COTUIT HARBOR
MASSACHUSETTS

SURVEY

(REVIEW OF REPORTS)

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

JULY 10, 1958

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407 - 423

SURVEY

REVIEW OF REPORTS

COTUIT HARBOR, MASSACHUSETTS

SYLLABUS

Cotuit Harbor, in the Town of Barnstable on the south side of Cape Cod, consists of three interconnected bays that are extensively used for recreational boating. The Division Engineer finds that prospective benefits to recreational boating are sufficient to warrant a Federal project to provide a 10-foot deep, 150-foot wide entrance channel from Nantucket Sound into West Bay; an 8-foot deep generally 100-foot wide channel from the West Bay entrance through West Bay and the drawbridge at Osterville to Great Bay; and an 8-foot deep, 60 foot wide channel from the West Bay entrance to Cotuit Bay. The estimated project first cost is $671,000 (April 1958), with annual charges estimated at $53,700 an and annual benefits of $61,200. The benefit-cost ratio is 1.1.

The recommendation is made subject to the requirements that local interests provide all necessary lands, easements, rights-of-way and spoil disposal areas; hold and save the United States free from damages; construct and maintain two public landings; and make a cash contribution of 50 percent of the first cost of construction. Federal first costs are estimated (April 1958) at $25,000 for pre-authorization studies, $320,000 for construction and $6,000 for navigation aids. Federal maintenance costs are estimated at $29,200 annually for channel maintenance and $900 annually for maintenance of navigation aids. Local costs are estimated at $320,000 as the cash contribution and $14,000 for construction of the two required public landings.

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
150 CAUSEWAY STREET
BOSTON 14, MASS.

NEDGW 10 July 1958

SUBJECT: Survey (Review of Reports) of Cotuit Harbor, Massachusetts

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

AUTHORITY

1. This report is submitted in compliance with the following resolution adopted January 28, 1947 by the Committee on Public Works of the House of Representatives, United States Congress:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Cotuit Harbor, Massachusetts, contained in House Document Numbered 167 Fifty-sixth Congress, First Session, with a view to determining if improvement of Cotuit Harbor and West Bay in the interest of navigation is advisable at this time."

2. A preliminary examination report submitted by the Division Engineer on April 20, 1948, was reviewed by the Board of Engineers for Rivers and Harbors, and a survey recommended. A study of survey scope was authorized by the Chief of Engineers on October 1, 1948.

SCOPE OF STUDY

3. Extensive investigations have been made of Cotuit Harbor for this report. A detailed hydrographic survey, including soundings and probings, was made to determine the character and volume of materials to be dredged. Studies have been made of the effect of the desired improvements on the shore lines of the area. Available maps and other data pertaining to the harbor have been consulted and engineering and economic studies made. A public hearing was held at Cotuit on September 12, 1947. This hearing and other conferences with local interests are described under Improvement Desired.

DESCRIPTION OF NAVIGATION CONDITIONS

4. Cotuit Harbor, located on the south shore of Cape Cod, Massachusetts, and abutting Nantucket Sound, lies about 6 miles west of Hyannis Harbor, and 16 miles east of Wood's Hole. The harbor consists of three interconnected bays separated by two islands, Osterville Grand and Little Islands. Cotuit Bay is situated to the west, Great Bay to the north, and West Bay to the east of these islands. Cotuit Bay is connected with West Bay by a narrow waterway, the Seapuit River, which lies south of Osterville Grand Island and separated from Nantucket Sound by a long sand island known as Dead Neck. Depths in the three bays and in the waterways which connect them range to about 17 feet with controlling depths in the channels ranging from 5 to 8 feet.

5. The Cotuit Bay entrance to the harbor, which lies across a shoal between Dead Neck and Poponesset Beach, has been dredged by the Commonwealth of Massachusetts. The natural movement of sand in the vicinity of the entrance forms a sand bar which moves continually. The natural depth of water over this bar is about 3 feet. As a result of the difficulty experienced in maintaining this channel the West Bay entrance was also dredged by the Commonwealth. In 1954, a portion of the Cotuit Bay entrance channel was redredged to 9 feet, with the remainder left at a controlling depth of 6 feet.

6. The West Bay entrance has been maintained by the Commonwealth of Massachusetts at about 8 feet for the past few years. The channel passes between two stone jetties which extend from both sides of the entrance into Nantucket Sound. The eastern jetty was extended to the 5-foot depth contour in Nantucket Sound in 1953 in an effort to reduce maintenance dredging. The channel was last dredged in 1953, and the controlling depth at the entrance is now about 7 feet. From the West Bay entrance the controlling channel depth through West Bay to Osterville is 8 feet, through the Seapuit River to Cotuit Bay is 6 feet, from Osterville to Great Bay is 5 feet, and through the Narrows between Great Bay and Cotuit Bay is 4 feet.

7. The harbor is well sheltered from winds and waves from all directions. It contains about 5 miles of protected waterway and an area of over 1,000 acres. Cotuit Bay, West Bay and Great Bay are used principally by recreational craft and are the scene of considerable yachting activity. There are oyster beds in several locations but little use has been made of them in recent years.

8. The mean and spring tidal ranges at Cotuit are 2.5 and 3.0 feet, respectively. Minus tides of 2.5 feet occur infrequently. The locality is shown on United States Coast and Geodetic Survey Charts numbered 259, 1208 and 1209 and on the maps accompanying this report.

TRIBUTARY AREA

9. The immediate tributary area is composed of the villages of Osterville and Cotuit, which are sub-divisions of the town of Barnstable, the county-seat of Barnstable, Mass. The area is a well known summer resort possessing some of the finest summer residences on Cape Cod. Industrial activity is very small. Two small boat building yards are located in Osterville. Recreational boats of all types up to 50 feet in length are built in these yards. At one time, oyster fishing was engaged in extensively by a large portion of the permanent population. In recent years this activity has dwindled to negligible quantities.

10. The area is served by a branch line of the New Haven Railroad, with direct service to Boston and to New York in the summer months. There is an airport with commercial flights direct to Boston and New York. A network of good roads serves the area with connections to major highways.

BRIDGES AFFECTING NAVIGATION

11. The waterway between West Bay and Great Bay is crossed by a bascule highway bridge connecting Little Island with the mainland near Osterville. The plans for this structure, which has a horizontal clearance of 31 feet and closed vertical clearance of 15 feet at mean low water, were approved by the Under Secretary of War on September 19, 1946. This bridge is usually unattended from October to May.

PRIOR REPORTS

12. The only prior report, a preliminary examination completed August 19, 1899 and published as House Document No. 167, 56th Congress, 1st Session, is the report under review. This report was unfavorable to dredging the Cotuit Bay entrance and removing boulders in the channel.

13. Under the present authority an unpublished preliminary examination report was submitted April 20, 1948 and reviewed by the Board of Engineers for Rivers and Harbors. This report was favorable to survey study.

EXISTING CORPS OF ENGINEERS PROJECT

14. No federal navigation project has been authorized at Cotuit harbor.

OTHER IMPROVEMENTS

15. For many years, the Commonwealth of Massachusetts, in cooperation with the Town and County of Barnstable, has maintained channels in Cotuit Bay, West Bay and Seapuit River. This work includes the construction of jetties at the entrance to West Bay, and shore protection works. The amounts thus expended to and including 1946 protection are as follows:

Location	Local Contribution	State Contribution	Total
Cotuit Harbor (including shore protection work in amount of $17,000, and dredging Bluffs Pt. to outer channel)	$47,345	$112,529	$159,874
West Bay (including dredging and jetty work)	37,516	124,607	162,123
Seapuit River (dredging)	13,000	12,111	25,111
Totals to 1947	$97,861	$249,247	$347,108

16. Since 1946 there has been considerable work done by the State and local interests as shown below:

Date	Location	Volume of Dredging	Total Expenditure
1947	Cotuit Bay and West Bay entrances	44,000 c.y.	$34,320
1950	West Bay and Seapuit River	67,400 c.y.	$68,748
1953	West Bay Entrance and Great Bay	46,342 c.y.	53,293
1953	Lengthen east jetty at West Bay entrance		35,045
1954	Cotuit Bay entrance	22,695 c.y.	53,331
1955	Hurricane repairs of Seapuit River channel and replacement of material washed from Dead Neck	29,500 c.y.	27,730
1957	Prince Cove	103,500 c.y. (est.)	92,265
		Total	$364,732

17. The Town of Barnstable maintains markers in the various channels throughout the area and a lighted beacon on the tip of the jetty at the West Bay entrance. The channel markers consist of spherical buoys and barrels. In addition, private interests have dredged private mooring basins and short access channels.

TERMINAL AND TRANSFER FACILITIES

18. The two boat yards in the harbor have four piers at which gasoline, oil and other supplies can be obtained, six marine railways with capacities up to 40 tons, and storage facilities for about 275 boats. The Wianno Yacht Club also maintains a pier at Osterville. There are town landings located between the two boat yards, in Great Bay, and West Bay, and a town pier at Cotuit. There are many privately owned landings. Gasoline and supplies are available only at the boat yards. There are sufficient hotel accomodations at both Cotuit and Osterville to meet the needs of visiting yachtsmen.

19. There is one pier, operated by a shellfish concern in Cotuit Bay, with facilities for handling shellfish.

IMPROVEMENT DESIRED

20. A public hearing was held at Cotuit, Massachusetts, on September 12, 1947, to determine the nature and extent of improvement desired by local interests, and to give interested parties an opportunity to be heard. Present at the hearing were private citizens and representatives of the Commonwealth of Massachusetts, the Town of Barnstable, boat building interests in the area, oyster growers, and yachting interests. Improvement of the waterway was proposed by a group of persons made up of yachting interests and the local boat yards in the Osterville area, an operator of a large hotel in Cotuit, and officials of the Town of Barnstable. They proposed construction of channels 12 feet deep, 200 feet wide into Cotuit Bay and to the head of West Bay, 100 feet wide from Cotuit Bay through Great Bay to West Bay, and 60 feet wide through the Seapuit River.

21. At the hearing, and subsequently, certain local interests opposed construction of substantial improvements in Cotuit Bay on the grounds that adequate facilities for recreational boating could better be developed at West Bay, and that greatly increased boating in Cotuit Bay would cause a pollution problem at the beaches in that location.

22. In 1950, and in 1956, local interests were again consulted as to their desires for improvement. As studies made for the preliminary examination indicated that maintenance of the entrance to Cotuit Bay would be difficult, and as it became apparent that there was considerable local opposition to major improvement of Cotuit Bay, the original proponents withdrew their request for the Cotuit Bay entrance channel.

EXISTING AND PROSPECTIVE COMMERCE

23. The only reported commerce at Cotuit Harbor pertains to shellfishing. In 1947 local interests reported 29,500 bushels of shellfish shipped from Cotuit. In 1950 the United States Fish and Wildlife Service estimated the average annual value of the shellfish industry at $64,000. Most of the work involved on cultivating the shellfish beds is done in small boats with only a few trips annually by larger craft drawing about 7 feet. Local interests reported that there was very little shellfishing activity in 1956.

VESSEL TRAFFIC

24. No record is kept of vessel traffic in Cotuit Harbor. Some indication of the traffic between West Bay and Great Bay may be derived from the number of openings in the bascule bridge. The record of openings for 1956 is as follows: 17 in April, 21 in May, 37 in June, 514 in July, and 290 in August. Records were unavailable for September and October.

25. There are essentially two fleets in Cotuit Harbor, one based in West Bay and Great Bay, the other in Cotuit Bay and the Seapuit River. The number, character, size and value of craft of the two fleets at present are shown in Table 1.

TABLE 1

COMPOSITION OF FLEETS

West Bay and Great Bay Fleet

Type of Craft	Length (feet)	Number of Craft	Total Depreciated Present Value
Outboards	20 or less	100	$ 50,000
Inboards	16-25	100	250,000
Cruisers	25-40	40	240,000
	40-50	15	187,500
	50-60	6	150,000
	60-75	0	
	75 up	4	350,000
Sails	15 or less	35	14,000
	15-20	30	19,500
	20-30	25	37,500
Auxiliary Sail	30-40	7	52,500
Charter Boats	30-40	4	16,000
Total		366	$1,367,000

366
16
514

TABLE 1 (cont.)

Cotuit Bay and Seapuit River

Type of Craft	Length (feet)	Number of Craft	Total Depreciated Present Value
Outboards	20 or less	40	$20,000
Inboards	16-25	40	100,000
Cruisers	20-30	12	66,000
	30-45	8	72,000
Sail	15 or less	50	20,000
	15-30	15	22,500
Auxiliary Sail	50-60	1	22,500
Total		166	$ 323,000

DIFFICULTIES ATTENDING NAVIGATION

26. Navigation difficulties at Cotuit Harbor are those attendant on inadequate depths in the existing narrow and winding channels. The West Bay entrance channel is exposed to ocean swells which ground out boats that would have adequate clearance in calm water. The channels in West Bay and the Seapuit River are narrow and difficult to navigate at night or in bad weather. Because the channels from West Bay to Great Bay are shallow, very few boats go into Great Bay for anchorage.

WATER POWER AND OTHER SPECIAL SUBJECTS

27. The waterway is tidal and matters of water power or flood control are not pertinent to this report. Local interests objected to substantial improvements in Cotuit Bay on the grounds that increased recreational boating would cause a pollution problem at the beaches there. These interests have interposed no objection to improvement of the narrow Seapuit River channel.

28. The Fish and Wildlife Service of the United States Department of the Interior has been consulted as to possible damage to fish and wildlife. They report that the local shell fishermen are not particularly concerned with possible direct damage to the shellfish beds, except that the shellfish may be smothered by silt if the work is done during the summer. They also believe that a large fleet of pleasure craft would cause a bacterial pollution in Cotuit Bay that would require closing the beds to fishing. The Fish and Wildlife Service considers that if the pleasure boats were not subjected to controls regarding the disposal of organic waste, the most serious inconvenience that might be expected as a result of the desired improvement would be the interruption of

quahog fishing during the summer and a delay to the beginning of oyster operations. No other fish or wildlife resources of any significance appear to be involved in the project.

29. The average annual receipts from shellfishing in Cotuit Harbor were estimated in 1950 to be $30,000 from oysters, $30,000 from quahogs, and $4,000 from scallops. Local interests have indicated that the oyster business has greatly declined since then. It is not considered that the shellfishing industry will be significantly affected by the improvement recommended.

PLANS OF IMPROVEMENT

30. All improvements desired by local interests have been considered during the preparation of this report. In addition, modifications of the desired improvements have also been considered. The extent of improvement considered for each location in the harbor is described below.

31. West Bay Entrance Channel. Local interests requested a 12-foot deep and 200-foot wide entrance channel, extending northerly from Nantucket Sound into West Bay. Alternate improvements considered for this entrance consist of 10 and 8-foot deep channels, 150 feet wide, extending in a northwesterly direction from Nantucket Sound to the tip of the easterly jetty at the entrance and then northerly into West Bay.

32. Although an entrance channel having the same depth as the protected channels would have a lower initial cost because of the exposed location of the channel and the reduction in effective depth which would result from waves, it is considered that the entrance channel should be 2 feet deeper than would be needed in a protected area. Without this additional depth the ocean swells that frequently occur here would restrict the use of the channel and as a result limit growth of the recreational use of the harbor.

33. Consideration has been given to the desirability of extending the present jetty on the east side of the West Bay entrance in order to reduce channel maintenance. However, the data now available are not adequate to permit a reliable evaluation of the effect that a jetty extension would have on the rate of shoaling in the entrance channel. It has been estimated that the 10 foot deep, 150 foot wide channel would shoal at the rate of 7100 cubic yards of material per year and the 8 foot deep, 150 foot wide channel would shoal at the rate of 5,400 cubic yards of material per year. Most of this shoaling would occur in the 2,600 foot long section seaward of the present jetty. The above estimate is considered conservative and accurate enough for evaluation of maintenance of the channel, but not reliable enough for use in estimating benefits to justify extension of the jetty.

34. West Bay to Great Bay Channel. Local interests requested a 12-foot deep channel 200 feet wide from the West Bay entrance channel through West Bay and the drawbridge at Osterville to deep water in Great Bay. Alternate improvements considered would provide an 8-foot or 6-foot deep channel 100 feet wide. All channels have been narrowed to the existing 31 foot horizontal clearance at the drawbridge. To leave berthing space at the present Osterville terminal facilities the channels have been limited to a width of 60 feet for a distance of 850 feet north from the drawbridge.

35. Seapuit River Channel. Local interests requested a 12-foot deep channel, 60 feet wide, from the West Bay entrance channel through the Seapuit River to deep water in Cotuit Bay. Alternate improvements considered would provide 8-foot and 6-foot channels 60 feet wide. In general, channel width of 100 feet is considered necessary for safe navigation by sailboats in open areas. About 30 percent of the boats now in the harbor are sailboats. Because the Seapuit River is relatively sheltered and navigation easier because the banks are near the channel, a channel width of 60 feet is considered adequate.

36. Dead Neck, which lies between the Seapuit River and the Sound, has been broken in the past by erosion and wave action. Future breakthroughs could be prevented by building up the outer beach of Dead Neck with construction and maintenance spoil from the navigation improvements. Use of Dead Neck as a spoil area has been considered as part of improvements of the Seapuit River channel.

37. Narrows Channel. Local interests requested a 12-foot deep channel 100 feet wide through the Narrows between Cotuit Bay and Great Bay. Alternate channels 100 feet wide and 6 feet or 8 feet deep have also been considered.

38. Plans of Improvement. Nine alternate plans of improvements have been studied in detail. The improvements desired by local interests were considered as Plan A. Other plans, with various modifications of channel locations and depth, were considered as plans B through I. The plans considered are summarized in Table 2.

TABLE 2

SUMMARY OF IMPROVEMENTS CONSIDERED

	Depth of Channel (in feet)				
	Entrance Channel	West Bay to Great Bay	Seapuit River	Narrows	Total Length of Channels in Plan (miles)
Plan A	12	12	12	12	5.2
Plan B	10	8	8	-	4.2
Plan C	10	8	-	-	2.6
Plan D	10	8	-	8	3.3
Plan E	10	8	8	8	4.9
Plan F	10	8	6	-	4.2
Plan G	8	6	6	-	4.1
Plan H	8	6	-	6	3.2
Plan I	8	6	6	6	4.7

39. The costs and benefits of all plans considered in the study are included in detail in the Appendix. On the basis of evaluated benefits and costs Plan B appears to be the most favorable plan of improvement. Therefore, details of costs, charges and benefits have been included in the text of this report for Plan B.

SHORELINE CHANGES

40. It is considered that dredging the desired channels in Cotuit Harbor would have very little effect on the adjacent shore lines. The erosion of Dead Neck just west of the West Bay entrance is not expected to increase as a result of the deeper entrance channel. The outer beach of Dead Neck should be used as a spoil disposal area for dredged material to build up the Neck and protect the Seapuit River channel. Such use would not make a major change in the shoreline and would reduce the effect of the present erosion.

REQUIRED AIDS TO NAVIGATION

41. The United States Coast Guard has been consulted and has advised that additional aids to navigation will be required. For Plan B it was estimated that 8 can buoys and 7 nun buoys would be required at a first cost of $6,000. The annual maintenance cost for aids to navigation for Plan B was estimated at $900.

ESTIMATES OF FIRST COST

42. The estimates of the first cost for all plans of improvement considered in this report are presented in Table 3. Prcbings taken for the study indicated that all dredging would be in mud ana sand. Dredging quantities were computed in terms of in place measurement with 1 foot of overdepth and 1 on 3 side slopes. Dredging costs are based on hydraulic dredging with prices current in April 1958. The estimated first cost of construction for Plan B, the recommended plan, is detailed below:

Project Construction:	
Channel Construction, Dredging 335,000 c.y. (including contingencies)	$595,000
Pre-Authorization Study Costs	25,000
Engineering and Design	9,000
Supervision and Administration	36,000
	$665,000
Other Construction:	
Aids to Navigation	6,000
Total estimated project cost (April 1958)	$671,000

TABLE 3

ESTIMATED FIRST COSTS OF CONSTRUCTION
ALL PLANS

Plan	First Cost of Construction (incl. overhead & cont.)	Navigation Aids	Total
A	$1,695,000	$7,000	$1,702,000
*B	665,000	6,000	671,000
C	445,000	4,000	449,000
D	535,000	5,000	540,000
E	735,000	7,000	742,000
F	535,000	6,000	541,000
G	325,000	6,000	331,000
H	265,000	5,000	270,000
I	360,000	7,000	367,000

* Recommended plan.

ESTIMATES OF ANNUAL CHARGES

43. Estimates of the annual charges for all plans of improvement studied in this report are presented in Table 4. Annual charges have been computed using a project life of 50 years and an interest rate of 2.5 percent. Channel maintenance costs are based on estimated shoaling rates. The plan B annual shoaling rates are 0.3 feet in the entrance channel, 0.08 feet in the West Bay channel, and 0.17 feet in the Seapuit River channel. The estimated annual charges for Plan B are detailed below:

Project Construction:

Interest ($665,000) (0.025)	$16,600
Amortization ($665,000) (0.01026)	6,800
Maintenance dredging (13,000 c.y. @ $2.25/c.y.)	29,200
	$52,600

Aids to Navigation:

Interest & Amortization	200
Maintenance	900
	$1,100

Total Annual Charges (April 1958) $53,700

TABLE 4

ESTIMATES OF ANNUAL CHARGES

ALL PLANS

Plan	Project Construction	Navigation Aids	Total
A	$113,000	$1,300	$114,300
*B	52,600	1,100	53,700
C	38,000	710	38,710
D	43,000	870	43,870
E	56,900	1,300	58,200
F	47,300	1,100	48,400
G	34,100	1,100	35,200
H	27,100	870	27,970
I	36,500	1,300	37,800

* Recommended Plan.

ESTIMATES OF BENEFITS

44. Benefits from improvement of Cotuit Harbor would accrue to existing and prospective recreational boating. Benefits were evaluated for the desired plan of improvement and for all other considered plans. Benefits for plan "B", the plan having the highest benefit-cost ratio, are evaluated in detail herein. All other plans were evaluated by similar methods and are shown in Table 8

45. Geographically the harbor is separated into two general areas of which the combination of Great Bay and West Bay may be considered one area and Cotuit Bay-Seapuit River the other. Two separate fleets are based in these areas each of which would benefit in different degree from an improvement. For this reason benefits have been evaluated separately for each fleet and the totals combined to compare with overall cost of improvement.

46. The computation of benefits for the existing fleet entailed comparison of the percentage of the ideal annual for-hire return which the fleets now experience with the percentage that would be experienced after improvement. In general, the ideal return for recreational boats varies according to size and type of boat, and is expressed in terms of percentage of the average depreciated value of the boat. For this report the ideal return varied from 13 percent for outboard motor boats to 8 percent for the largest cabin cruiser. In arriving at the present value of the ideal return, consideration was given to such factors as deficiencies in present channel requirements for length and draft of individual types of boats, i.e., depth, alignment of channels and accessibility of the harbor. Determination of the present value was predicated on the extent to which these deficiencies preclude optimum use of the harbor. Future value represents the value to be enjoyed after an improvement of the harbor eliminates or reduces the deficiencies. Benefits from this source for plan "B" are estimated as $11,600 for the Great Bay-West Bay area and $1,670 for the Cotuit Bay-Seapuit River area; a total of $13,270 for the harbor. The benefit is reduced by $400 to allow for boats on cruise leaving a net total of $12,870 as shown in Table 5.

TABLE 5

BENEFITS - EXISTING FLEET

GREAT BAY - WEST BAY FLEET

PLAN "B"

Type of Craft	Length ft.	No. of Boats	Depreciated Value Av.	Depreciated Value Total	Percent Return % of Ideal Ideal	Pres.	Future	Gain	Value $	Av. Days	ON CRUISE % of Season	Value
Outb'ds	20-less	100	500	50,000	13	100	100	-				
Inb'ds	16-25	100	2500	250,000	10	100	100	-				
Cruisers	25-40	40	6000	240,000	9	100	100	-				
	40-50	15	12500	187,500	9	90	100	0.9	1690	2	1.2	20
	50-60	6	25000	150,000	8	85	100	1.2	1800	3	1.8	30
	60-75	-	50000	-	-	80	95	-	-			
	75-90	4	87500	350,000	8	70	95	2.0	7000	7	4.2	300
Sail	15 -less	35	400	140,000	12	100	100	-	-			
	15-20	30	650	19,500	12	95	100	0.6	120			
	20-30	25	1500	37,500	11	90	100	1.1	410			
Aux Sail	30-40	7	7500	52,500	9	90	100	0.9	470	7	4.2	20
		-	19000	-		80	95					
		-	25000	-		70	90					
Charter	30-40	4	4000	16,000	8	90	100	0.8	130			
									$11,600			$370

COTUIT BAY - SEAPUIT RIVER FLEET

Outb'ds	20-less	40	500	20,000	13	100	100					
Inb'ds	16-25	40	2500	100,000	10	100	100					
Cruisers	20-30	12	5500	66,000	10	100	100					
"	30-45	8	9000	72,000	9	95	100	0.5	360			
Sailboats	15 -less	50	400	20,000	12	100	100					
"	20-30	15	1500	22,500	12	80	100	2.2	500			
Aux Sail	50-60	1	22500	22,500	9	70	100	3.6	810	7	4.2	30
									1670			30
Totals		532							13,			$400

Total Benefits to Existing Local Fleet = $13,2 - $400 = $12,8

47. Over the years Cotuit Harbor, located in a rapidly growing summer resort area, has enjoyed a considerable growth of recreational boating activity. In the last decade the fleet has been increased by the addition of approximately 232 boats, a rate of slightly over 23 boats per year. While it is not considered that this rate will prevail indefinitely, it is conservatively estimated that, even without improvement, normal expansion of boating in the next fifty years will add an equal amount of boats to the area as is now present. Since this addition will double the present fleet during the anticipated life of the project, benefits have been evaluated for these boats, and are estimated to equal one half of the benefits that will accrue to the existing fleet or $6,450 annually.

48. As a result of field investigations and advice from local interests, it is estimated that 59 boats will be added to the fleet immediately after improvement of the harbor. Of these boats it is estimated that 30 would be new and 29 would transfer from other harbors. Benefits for the new boats have been computed on the basis of their receiving the major portion of the ideal for-hire return. Details of the benefits thus computed for plan "B" are shown on Table 6 and are estimated to total $35,220 annually.

49. Benefits for the 29 transferred boats have also been computed. Some of these boats are owned by residents of the nearby area and kept in deeper harbors as far away as Plymouth and New Bedford. Others are owned by summer residents of other New England areas that would move to Cotuit if the harbor were adequate. Because these owners are now considered to be receiving more return at their present location than they would if based in the unimproved harbor of Cotuit, the benefits to be derived will not amount to as much as the gain for equivalent boats presently based in Cotuit. It is estimated that the gain to the boats transferred will amount to two-thirds of the gain to the equivalent Cotuit based boats. The total benefits for transferred boats will thus amount to $4210 for plan "B".

TABLE 6

BENEFITS FOR NEW BOATS ADDED TO FLEET
AFTER IMPROVEMENT

PLAN "B"

Type of Craft	Length Ft.	No. of Boats	Depreciated Value Av.	Depreciated Value Total	Percent Return % of Ideal Ideal	Pres.	Future	Gain	Value $	On Cruise Av. days	On Cruise % of Season	Value
				GREAT BAY - WEST BAY FLEET								
Cruisers	40-50	3	$12,500	$37,500	9	0	100	9	3380	2	1.2	40
	50-60	1	25,000	25,000	8	0	100	8	2000	3	1.8	40
	60-75	1	50,000	50,000	8	0	95	7.6	3800	7	4.2	160
Sailboats	20-30	5	2,000	10,000	11	0	100	11	1100	-	-	-
Aux. Sail	30-40	5	15,000	75,000	9	0	100	9	6750	7	4.2	290
	40-50	2	20,000	40,000	8	0	95	7.6	3040	7	4.2	130
Charter	30-40	1	8,000	8,000	8	0	100	8	640	-		
Total		18		245,500					20710			660
				COTUIT BAY-SEAPUIT RIVER FLEET								
Cruisers	30-45	1	10,000	10,000	9	0	100	9	900	1	0.7	10
	45-60	2	25,000	50,000	8	0	100	8	4000	3	1.8	70
	60-75	1	50,000	50,000	8	0	95	7.6	3800	7	4.2	160
Sailboats	20-30	3	2,000	6,000	11	0	100	11	660	-	-	
Aux Sail	30-40	3	15,000	45,000	9	0	100	9	4050	7	4.2	170
	40-50	1	20,000	20,000	8	0	100	8	1600	7	4.2	70
Charter	30-40	1	8,000	8,000	8	0	100	8	640	-	-	-
		12		189,000					15,650			480
Total		30		$434,500					$36,360			$1140

Total Benefits = $36,360 - $1140 = $35,220

50. Transient craft presently visiting the harbor average about 25 boats weekly for stays of 2 to 3 days. Over the boating season of 165 days this amounts to 1500 boat-days. These transient craft are equivalent to 9.1 locally based boats. Future transient visits, due to normal growth of boating, are estimated to be 50 percent of this total or 750 days. Increase in visitation of transient craft because of improvement is estimated at about 19 percent of the present volume or 280 days. The anticipated total of 2,530 transient boat-days is equivalent to 15.3 locally based boats. Present transient craft consist chiefly of the larger classes of boats that enter primarily for service. Benefits have been evaluated for transient craft equivalent to 13.5 locally based boats. The computation of benefits for present and future transient craft under Plan B is shown in Table 7.

TABLE 7

BENEFITS FROM TRANSIENT CRAFT (PRESENT & FUTURE)

PLAN "B"

Type of Craft	Length in feet	Presently Visiting: Average Depreciated Value	Presently Visiting: Boat Days	Presently Visiting: Percent Return	Presently Visiting: Value	Additional Visitors Attracted by Improvement: Average Depreciated Value	Additional Visitors Attracted by Improvement: Boat Days	Additional Visitors Attracted by Improvement: Percent Return	Additional Visitors Attracted by Improvement: Value
Cruisers	25-40	6,000	200	-	-	-	-	-	-
	40-50	12,500	300	0.9	210	12,500	20	0.6	10
	50-60	25,000	200	1.2	360	25,000	40	0.8	50
	60-75	50,000	100	1.2	360	50,000	50	0.8	120
Sailboats	20-30	1,500	100	1.1	10	2,000	20	0.7	-
Aux. Sail	30-40	12,000	500	0.9	330	15,000	40	0.6	20
	40-50	18,000	100	1.2	130	20,000	60	0.8	60
	50-60	-	-	-	-	25,000	50	1.1	80
Total			1500		$1400		280		$340

	Boat Days	No. Equivalent Local Boats	Benefits
Presently visiting	1300	7.9	$1,400
50% Normal increase	650	3.9	700
Increase due to Plan B	280	1.7	340
			$2,440

51. Cotuit Harbor is a very well sheltered harbor and is conveniently located with respect to Nantucket Sound. At present it is used to a limited extent as a harbor of refuge by small boats from less protected nearby harbors. It is considered that improvement will enable larger boats to utilize the harbor for refuge. Although there are insufficient data available to make a reliable monetary estimate of benefits to be derived in this respect, it is estimated that these would be small in view of the availability of adequate facilities at Hyannis Harbor and Wood's Hole. Therefore, no benefit is included for the value of Cotuit Harbor for refuge.

52. Additional benefits, which have not been evaluated monetarily, are those attributable to elimination or reduction of vessel damage. As no claims of vessel damage were made by local interests, either at the hearing or subsequently, it is considered that damage to vessels resulting from present harbor conditions is negligible. Commercial fishing in this locality consists entirely of oyster and quahog fishing. Boats used for this type of fishing are small shallow-draft vessels, principally powered by outboard motors. No benefits will accrue to this type of boat. Three or four trips a year of boats carrying seed oysters to the harbor are made. Since these boats are of relatively shallow-draft, it is considered that benefits to be derived from the three or four trips made are negligible.

53. Maintenance of the Seapuit River channel is dependent on the protection provided by Dead Neck. The plans of improvement including the Seapuit channel include disposal of spoil from construction and maintenance on the outer beach of Dead Neck to prevent a breakthrough. Local interests have offered the use of private beaches on West Bay and Great Bay for spoil disposal. Because these shores are now completely developed with expensive residences it is not expected that a material increase in property value would result from spoil disposal. It is therefore considered that no land enhancement benefit should be credited to the improvement.

54. Benefits for plan "B" are summarized below:

Benefits to locally based craft

Existing Fleet (increased use of 115 boats)	$12,890
Future Normal Growth (increased use of 58 boats)	6,450
New Boats (30 boats added because of improvement)	35,220
Transferred Boats (29 boats added because of improvement)	4,210

Benefits to Transient Craft

Present transient fleet (increased use of equivalent to 7.9 local boats)	1,400
Future normal Growth (increased use of equivalent to 3.9 local boats	700
New (equivalent to 1.7 local boats added because of improvement)	340
	$61,210

Total Evaluated Benefits

COMPARISON OF BENEFITS AND COSTS

55. The total construction costs, annual charges, and annual benefits and the benefit-cost ratios for all plans of improvement considered in this report are shown in Table 8. Plan A, the plan desired by local interests, shows an unfavorable benefit-cost ratio. Plans B, D, and E , all plans with 8 foot deep channels in the protected areas show favorable benefit-cost ratios. Plan B has the highest ratio. Plans G through I, all plans with 6-foot deep channels in West Bay and Great Bay, show unfavorable benefit-cost ratios.

TABLE 8

COMPARISON OF BENEFITS AND COSTS

	Plan A	*Plan B	Plan C	Plan D	Plan E	Plan F	Plan G	Plan H	Plan I
Channel Depths (feet)									
Entrance	12	10	10	10	10	10	8	8	8
West Bay-Great Bay	12	8	8	8	8	8	6	6	6
Seapuit River	12	8	-	-	8	6	6	-	6
Narrows	12	-	-	8	8	-	-	6	6
Total First Cost	$1,702,000	671,000	449,000	540,000	742,000	541,000	331,000	270,000	367,000
Total Annual Charges	114,300	53,700	38,710	43,870	58,200	48,400	35,200	27,970	37,800
Total Annual Benefits	64,590	61,210	38,380	48,830	61,210	44,580	13,550	10,250	13,550
Benefit to Cost Ratio	0.57	1.14	0.99	1.11	1.05	0.92	0.38	0.37	0.36
Locally Based Boats									
Total Number	859	857	830	849	857	842	815	807	815
Number Benefited	234	232	170	189	232	217	178	135	178
Transient Boats									
Total number of equivalent local boats	15.4	15.3	15.3	15.3	15.3	15.3	13.6	13.6	13.6
Number Benefited	13.6	13.5	13.5	13.5	13.5	13.5	6.4	6.4	6.4

56. Comparison of Plan B to Plan G, whose channels differ by 2 feet in depth, shows the effect of the deeper channels on benefits. Under Plan G,178 local and 6.4 equivalent transient boats would receive $13,550 in benefits. Provision of Plan B, featuring the deeper channels, would increase the benefits to the above boats by $10,620. In addition, 12 local boats, and 5.4 equivalent transient, which are included in the fleet of Plan G, but would not receive any benefits under this plan, would be benefited under Plan B by $2,540. Furthermore, provision of Plan B over Plan G would result in the addition of 42 local and 1.7 transient boats with benefits in the amount of $34,500. Under plan B, therefore, benefits of $61,210 would accrue to 232 locally based boats and to transient boats equivalent to 13.5 locally based boats.

PROPOSED LOCAL COOPERATION

57. Local interests should provide without cost to the United States all lands, easements, rights-of-way and suitable spoil disposal areas for the construction and maintenance of the project when and as required. They should also hold and save the United States free from damages that may result from the construction works and maintenance of the project.

58. The present town-owned public landing facilities are not considered to be adequate for the needs of recreational boating which will develop as a result of improvement of the harbor. It is considered that two additional public landings with adequate berths will be necessary. Initial construction cost of these landings is estimated at $14,000. One of these landings should be located in West Bay, southeast of the drawbridge, and the other in the area northeast of Point Isabella in Great Bay. It is also considered that local interests should continue to maintain the present landing facilities, expanding them as future needs develop. The cost of the public landings is considered to be self-liquidating.

59. The benefits to be derived from improvements of Cotuit Harbor are wholly recreational benefits which are 50 percent general and 50 percent local in nature. It is considered that local interests should bear a share of the project cost commensurate with that portion of benefits that are local in nature. Local interests should, therefore make a cash contribution of 50 percent of the construction cost of the navigation project, exclusive of aids to navigation. This local cash contribution for Plan B is estimated at $320,000. Maintenance of the navigation improvements and provision of aids to navigation are considered to be a Federal responsibility. Similar requirements of local cooperation should also apply to the other plans considered in this report.

60. Officials of the Commonwealth of Massachusetts and the Town of Barnstable have been consulted and have provided reasonable assurances that they would meet the necessary requirements of local cooperation for "Plan B", the plan found most favorable in this report.

APPORTIONMENT OF COSTS AMONG INTERESTS

61. The construction costs for navigation facilities should be apportioned among the interests that receive benefits. Because the benefits from improvement of Cotuit Harbor accrue to recreational boating, which are considered equally general and local in nature, the construction costs have been apportioned 50 percent to the Federal government and 50 percent to local interests. The apportionment of costs for Plan B is shown below:

a. Estimated Project First Costs

Federal	
Corps of Engineers: General navigation facilities	$640,000
Pre-Authorization study costs	25,000
Coast Guard: Navigation aids	6,000
	$671,000
Non-Federal (Non-self liquidating)	0
Total (April 1958)	$671,000

b. Estimated Annual Maintenance Costs

Corps of Engineers	$ 29,200
Coast Guard	900
	$ 30,100

c. Apportionment of First Costs

Federal	
Corps of Engineers: General navigation facilities (0.50) ($640,000)	$320,000
Pre-Authprization Study Costs	25,000
Coast Guard: Navigation aids	6,000
Total Federal First Costs (April 1958)	$351,000
Non-Federal	
Cash Contribution: General navigation facilities (0.50) ($640,000)	320,000
	$671,000

d. Annual Charges

Federal	
Interest (0.025) ($351,000)	$8,700
Amortization (0.01026) ($351,000)	3,600
Maintenance	30,100
Total Federal	$42,400
Non-Federal	
Interest (0.025) ($320,000)	8,000
Amortization (0.01026) ($320,000)	3,300
Total Non-Federal	$11,300
Total	$53,700

COORDINATION WITH OTHER AGENCIES

62. All Federal, State and local interests having interest in the improvement of Cotuit Harbor were notified of the public hearing held at Cotuit, Massachusetts, on 12 September 1947. Representatives and officials of the Commonwealth of Massachusetts, the Town of Barnstable, other local interests, the U. S. Fish and Wildlife Service, and the U.S. Coast Guard have all been consulted during the study concerning the effects of the proposed improvements on their activities.

DISCUSSION

63. Cotuit Harbor consists of three interconnected natural bays located in the heart of the summer recreational area of Cape Cod. The recreational business in the region has increased a great deal in recent years, and with it, recreational boating. The Osterville and Osterville Grand Island area has been extensively developed and has a large number of substantial summer residences. The Wianno Yacht Club as well as two boat yards are located in this area. The area around Cotuit has also developed extensively and includes a large colony of summer residents.

64. There is no existing Federal project at Cotuit Harbor. In the past the Commonwealth of Massachusetts in cooperation with the Town and County of Barnstable have expended $711,840 for channel dredging, jetty construction and hurricane repairs. The town of Barnstable has provided and maintained all navigation aids.

65. The improvements desired by local interests have been studied under Plan "A" which would provide 12-foot deep channels throughout the entire harbor. In addition, eight other plans were studied. Plans "B" through "E" provide a 10-foot entrance channel and 8-foot channels in West Bay to Great Bay, with and without a Seapuit River Channel, and with and without a Narrows channel. Plan F consists of a 10-foot entrance channel, an 8-foot channel in West Bay to Great Bay, and a 6-foot channel in the Seapuit River. Plans G through I consist of an entrance

channel 8 feet deep and 6-foot channels in West Bay to Great Bay, with and without a Seapuit River channel, and with and without a Narrows channel.

66. The 8-foot channels studied in Plans "B" through "E" would serve adequately all the needs of recreational boating in the Harbor. Because of hazardous navigational conditions caused by swells and minus tides in Nantucket Sound, a 10-foot deep entrance channel was included in these plans. The 6-foot channels, studied in Plans "G", "H" and "I" would not completely serve the needs of recreational boating, although they would benefit part of the existing fleet. The proposed channels generally follow the course of the existing channels through the harbor, straightening the alignment and easing the bends in the channels wherever possible.

67. In the economic analysis, justification for any of the above improvements was based primarily on the needs of recreational boating, since local interests neither desire nor anticipate any significant volume of commercial navigation. The present two fleets, based in the West Bay and Great Bay area, and in the Cotuit Bay and the Seapuit River area, consist of 366 and 166 boats, respectively. The majority draw less than 6 feet, with about one percent having drafts between 6 and 8 feet. For this reason the incremental benefits to be derived from Plan A over Plan B are small and would not increase to any extent in the future since it is considered that prospective increases of the fleet would consist largely of craft with less than 6-foot draft.

68. The channel in the Narrows, between Great Bay and Cotuit Bay, was not included in Plans B,C, F and G, because it is not considered essential in serving the navigational needs of the Cotuit Harbor fleets. The additional cost of providing a channel at this location would outweigh by far the small incremental benefits.

69. The provision of an improved channel in the Seapuit River has been estimated to yield sufficiently more benefits to justify Plan "B" over Plan "C" even though the first cost of construction would be higher. The basic reason for this lies in the fact that Plan "C" would provide benefits for the West Bay Cotuit fleet only. Plan "B" would provide benefits for the combined fleets, and provide a higher benefit-cost ratio for overall improvement of the harbor.

70. The benefits from the improvements under all plans have been estimated for each fleet separately. In the analysis of the effects of the improvements on the growth of the locally based craft, it was estimated that the West Bay and Great Bay fleet would increase by about 10 percent and the Cotuit Bay and Seapuit River fleet would increase by about 15 percent. These increases would consist of boats newly purchased

or transferred from other harbors, solely because of the improvements. In addition, an increase of the fleets has been estimated to average about 50 percent during the next 50 years as a result of normal growth, even if the harbor is not improved. The transient fleet has been estimated to amount to about 1,500 boat days annually at present. The normal growth of this is estimated to be 50 percent, and the increase because of the improvements estimated to be about 20 percent of the present. All benefits to the transient fleet were estimated to be derived from improvement of the West Bay and entrance channel only.

71. The total annual benefits which are associated with the plans were estimated to vary from $10,250 to $64,590 with $61,210 for Plan B. The first cost of construction including navigation aids was estimated to vary from $270,000 to $1,702,000 with $671,000 for Plan B. The annual charges, including all maintenance, vary from $27,970 to $114,300 with $53,700 for Plan B. From the estimates of annual benefits and costs it may be computed that the benefit to cost ratios are below 1.0 for Plans A, C and F through I and above 1.0 for Plans B, D, and E. Plan B is estimated to be the most economically favored plan with a benefit to cost ratio of 1.14.

72. An apportionment of costs made on the basis of evaluated benefits indicates that local interests should be required to make a cash contribution of 50 percent of the dredging costs of the improvement. The Federal Government would assume all periodic maintenance costs subsequent to the construction of the project. All necessary navigation aids would be provided and maintained by the U.S. Coast Guard.

73. Local interests should be required to hold and save the United States free from damages resulting from construction and maintenance of the project. As dredging by the hydraulic method is anticipated local interests should be required to provide adequate spoil disposal areas and all lands, easements and rights-of-way necessary for construction and maintenance. Spoil should be placed on Dead Neck to strengthen it and thus protect the Seapuit River channel from shoaling. It is not anticipated that any measurable land enhancement benefits will be derived from spoil disposal.

74. Local interests should be required to construct two public landings to serve Great Bay and West Bay, respectively. Cotuit Bay is now adequately served by the existing public facility. It is expected that local interests will maintain the existing facilities and expand them as the need arises in the future.

CONCLUSIONS

75. Economic analysis of costs and benefits anticipated for Plan A, the plan providing 12-foot channels desired by local interests, indicates that this plan is not economically justified. After study of several alternate improvements of Cotuit Harbor it is concluded that Plan B, the plan consisting of a 10-foot entrance channel into West Bay, and 8-foot channels in the Seapuit River, West Bay and Great Bay, provides amply for the needs of recreational craft in Cotuit Harbor and is economically justified. This plan with average annual charges of $53,700, would yield annual benefits to recreational craft amounting to $61,210, showing a benefit-cost ratio of 1.14. The total first cost of the improvement is (April 1958) $671,000, including $6,000 for aids to navigation and $25,000 for Pre-Authorization study costs.

76. Since the local benefits from the improvement are equal to the general benefits, an apportionment of cost has been made so that the local share of the cost of the general navigation facilities will equal the Federal share. On this basis, local interests should be required to contribute in cash 50 percent of the first cost of the improvement, an amount estimated at $320,000 (April 1958). Federal costs would consist of 50 percent of the first cost of dredging, all maintenance dredging costs, and the first costs and maintenance costs for aids to navigation. The Federal first cost is estimated at (April 1958) $351,000 with $30,100 annually for maintenance.

77. Local interests should be required to construct a public landing southeast of the drawbridge in West Bay to serve this area and another landing northeast of Point Isabella to serve Great Bay. The two public landings are estimated to cost $14,000 and are assumed to be self-liquidating. Local interests should not be required to provide a public landing in Cotuit Bay, since the existing public pier adequately serves this area.

78. Local interests should be required to hold and save the United States free from damages and provide all lands, easements, rights-of-way and spoil disposal areas necessary for the construction and maintenance of the project.

79. Local interests have been consulted and have indicated that Plan B would meet their needs and that they would make the required cash contributions and provide the necessary assurances when requested.

80. It is therefore concluded that a Federal navigation project as described in Plan B should be authorized for Cotuit Harbor. The Federal costs would be (April 1958) $25,000 for completed pre-authorization studies, $320,000 for channel construction, with $29,200 annually for channel maintenance plus $6,000 for aids to navigation with $900 annually for maintenance. Local first costs are estimated at $320,000 for cash contribution and $14,000 for the construction of the two required public landings.

RECOMMENDATION

81. It is recommended that a Federal navigation project be authorized at Cotuit Harbor, Barnstable, Massachusetts, at an estimated cost to the United States of $320,000 for construction and $29,200 annually for maintenance, to provide:

a. an entrance channel from Nantucket Sound into West Bay 10 feet deep, 150 feet wide, and about 0.8 miles long;

b. a channel from West Bay entrance through West Bay and the drawbridge at Osterville to Great Bay 8 feet deep, 100 feet wide in open areas, 31 feet wide through the drawbridge, and 60 feet wide for 850 feet north from the drawbridge; a total length of about 1.8 miles; and

c. a channel from West Bay entrance through the Seapuit River to Cotuit Bay 8 feet deep, 60 feet wide and about 1.6 miles long.

82. Improvement of Cotuit Harbor by the United States is recommended subject to the conditions that local interests:

a. Provide without cost to the United States all lands, easements, rights-of-way and suitable spoil disposal areas for the construction and maintenance of the project when and as required.

b. Hold and save the United States free from damages that may result from the construction works and maintenance of the project.

c. Provide and maintain without cost to the United States two suitable public landings or wharves with adequate berths in accordance with plans approved by the Chief of Engineers. One of the landings should be located southeast of the drawbridge to serve West Bay and the other should be located northeast of Point Isabella to serve Great Bay.

d. Make a cash contribution of 50 percent of the first cost of the Federal project construction, a contribution presently estimated at $320,000.

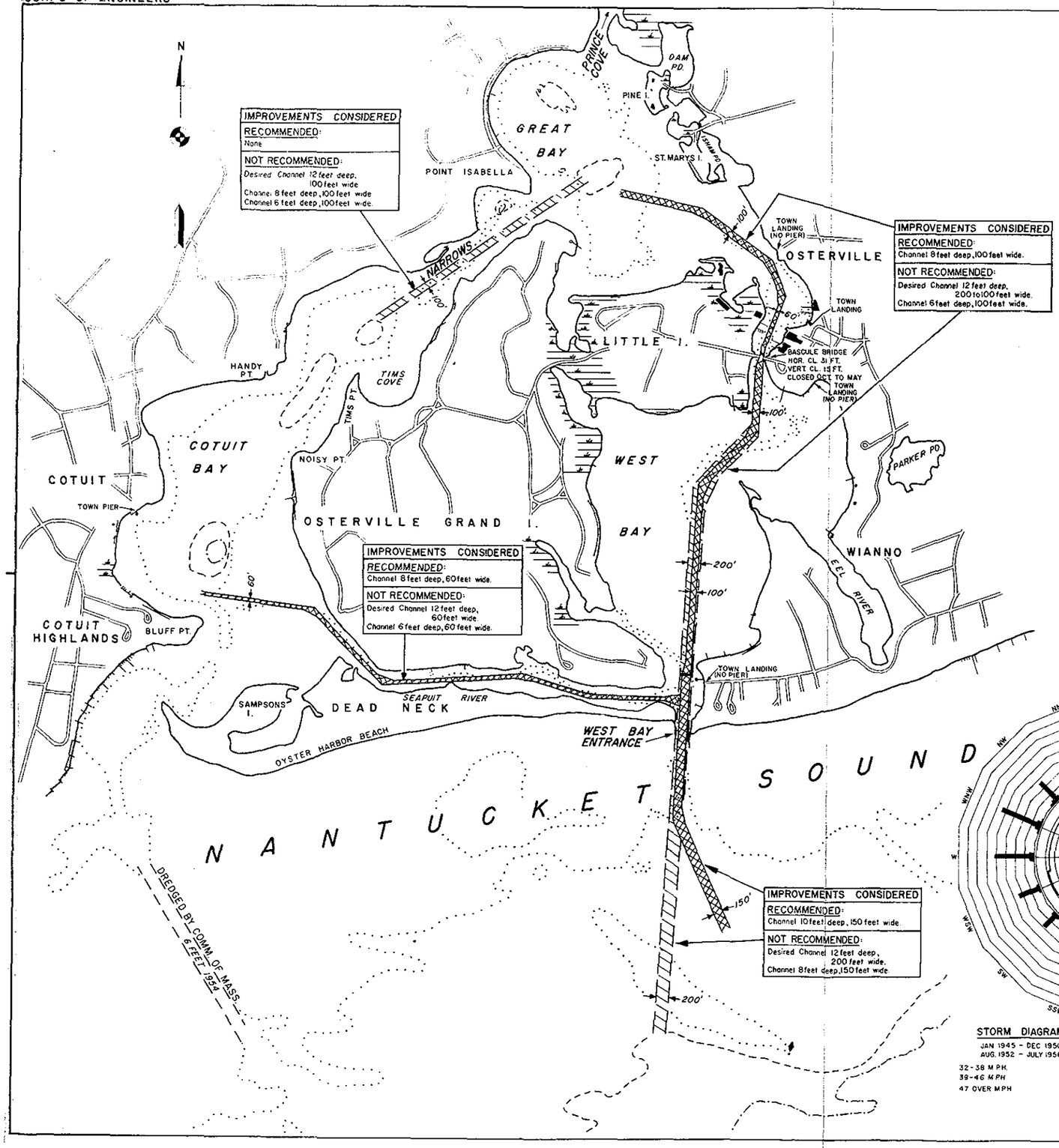
Incls:
Plate 1 - General Map
Plates 2-7 Survey Map
(6 Sheets)
Appendix - Cost and Benefits

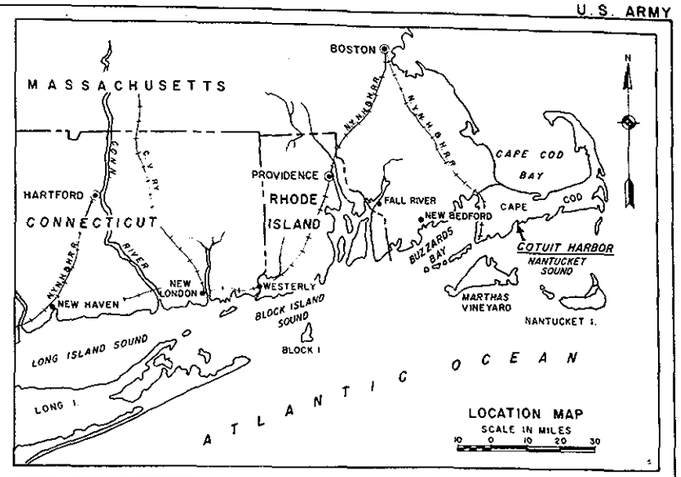
ALDEN K. SIBLEY
Brigadier General, U.S. Army
Division Engineer

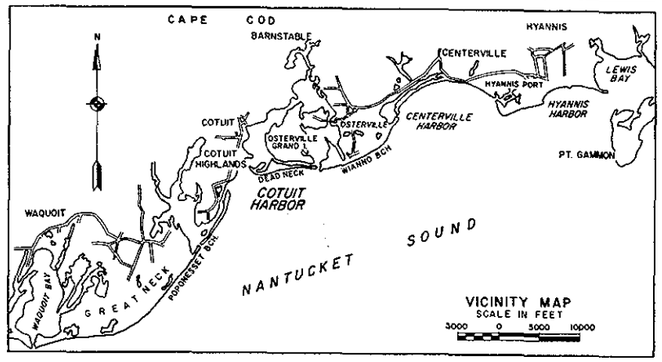
R 9/58

CORPS OF ENGINEERS

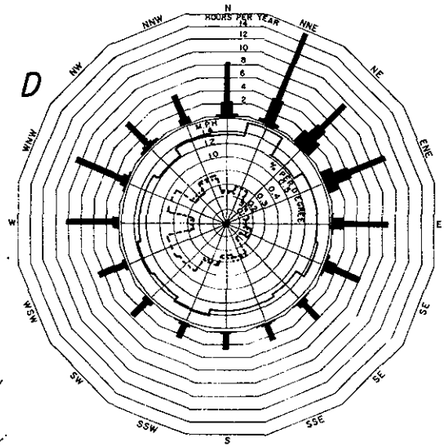
U.S. ARMY







WIND ROSE
AND
STORM DIAGRAM
NANTUCKET, MASS



STORM DIAGRAM
JAN 1945 - DEC 1950
AUG. 1952 - JULY 1956
32-38 M.P.H.
39-46 M.P.H.
47 OVER M.P.H.

WIND ROSE
AUG. 1952 - JULY 1956
DURATION, % PER DEGREE
MOVEMENT, % PER DEGREE
AVERAGE SPEED, M.P.H.

NOTES

Topography and hydrography from surveys by the U.S.C.E. and from U.S.C. & G.S. Chart No. 259.

LEGEND

- 6-FOOT DEPTH CONTOUR
- 12-FOOT DEPTH CONTOUR
- 18-FOOT DEPTH CONTOUR
- RECOMMENDED IMPROVEMENT
- IMPROVEMENT NOT RECOMMENDED

COTUIT HARBOR, MASS.
GENERAL MAP

IN 1 SHEET — SCALE IN FEET 1000 0 1000 2000

NEW ENGLAND DIVISION, BOSTON, MASS. JUNE 1957

APPROVED: John W. Leslie
SUBMITTED: [illegible]
APPROVED: Raymond A. Hufford
FOR CHIEF, U.S. ARMY ENGINEER
TO ACCOMPANY SURVEY REPORT DATED JULY 10, 1958
FILE NO Cotuit 3

PLATE I

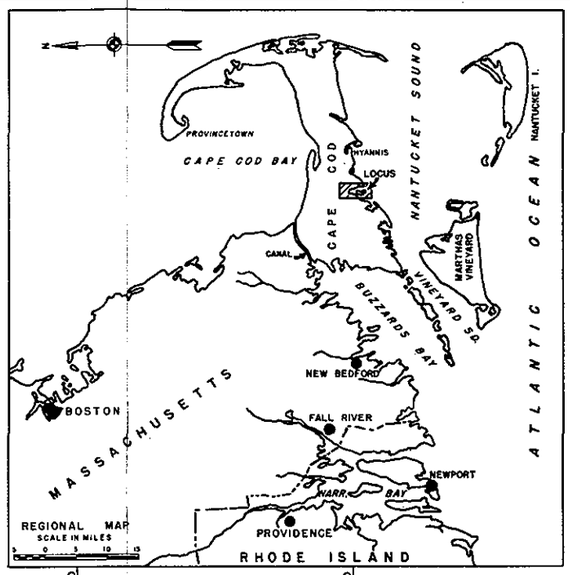
CORPS OF ENGINEERS

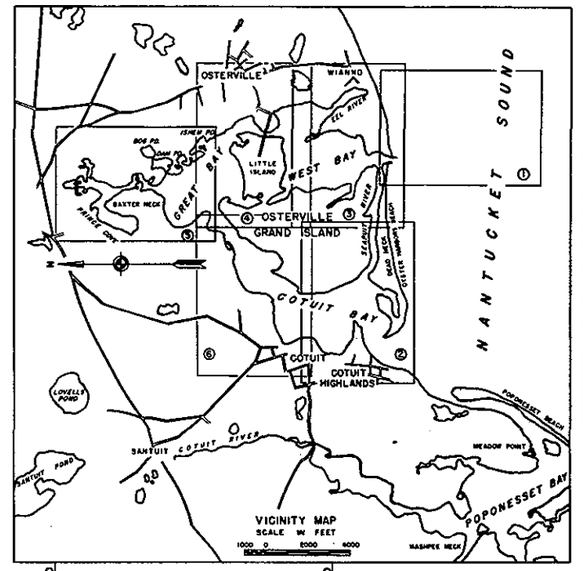
U. S. ARMY

PROBING TABLE

NUMBER OF PROBING	DEPTH IN FEET BELOW M.L.W. WATER*	PROBING	INDICATED MATERIAL	NUMBER OF PROBING	DEPTH IN FEET BELOW M.L.W. WATER*	PROBING	INDICATED MATERIAL
1	3.0	6.2	Coarse Sand	33	6.0	9.3	Loose Sand
2	10.6	+0.6	Large Boulders (Remains of Old Jetty)	34	7.3	12.4	Sand to Hard
3	8.6	12.7	Sand	35	4.8	8.2	Sand & Few Cobbles
4	3.9	7.2	Sand & Few Cobbles	36	5.0	9.2	"
5	3.3	6.1	Coarse Sand	37	5.1	8.2	"
6	4.3	8.4	" "	38	8.0	12.5	Sand to Hard
7	8.2	13.0	Sand	39	6.7	12.7	"
8	6.3	9.3	"	40	8.7	12.8	"
9	4.2	6.8	Coarse Sand & Few Cobbles	41	7.6	13.0	"
10	4.4	7.8	Hard Packed Sand	42	7.9	12.7	" to Hard
11	9.5	12.8	Sand	43	6.6	12.2	"
12	6.3	9.4	"	44	8.6	12.5	"
13	4.7	8.2	Hard Packed Sand & Few Cobbles	45	8.6	12.6	"
14	5.3	8.4	" " "	46	8.0	12.4	"
15	5.8	8.8	Sand & Few Cobbles	47	8.4	12.5	"
16	4.4	8.9	Hard Packed Sand	48	7.1	12.3	" to Hard
17	4.4	9.1	Coarse Sand & Few Cobbles	49	6.7	12.4	" " "
18	5.7	9.1	Hard Packed Sand	50	7.7	12.6	"
19	7.5	12.2	Sand to Hard	51	7.7	12.3	"
20	7.5	12.9	"	52	8.5	12.8	"
21	5.3	8.6	" & Few Cobbles	53	8.7	12.8	"
22	4.5	8.9	Hard Packed Sand & Cobbles	54	8.9	12.3	"
23	5.3	8.3	" " "	55	8.1	12.5	"
24	6.4	9.5	Sand	56	8.3	12.4	Hard Packed Sand
25	7.3	12.6	"	57	6.1	12.4	Sand
26	4.6	8.0	"	58	5.8	12.0	Hard Packed Sand
27	5.4	8.6	Hard Packed Sand & Few Cobbles	59	5.3	11.6	" " "
28	6.6	9.0	Loose Sand	60	5.4	11.8	" " "
29	5.2	12.3	Sand to Hard	61	4.9	12.0	" " "
30	5.1	8.3	Sand	62	5.7	12.1	" " "
31	4.9	9.1	"	63	6.7	12.1	" " "
32	5.5	8.8	Hard Packed Sand	64	8.4	11.8	"

*Does not reflect dredging by Comm. of Mass.





N 220 000 | N 219 000 | N 219 000 | N 217 000

E 902 000

N 223 000 | N 222 000 | N 221 000

N A N T U C K E T S O U N D

IMPROVEMENTS CONSIDERED
RECOMMENDED: Channel 10 feet deep, 150 feet wide.
NOT RECOMMENDED: Desired Channel 12 feet deep, 200 feet wide. Channel 8 feet deep, 150 feet wide.

E 901 000

E 900 000

E 899 000

LIGHT

WEST BAY ENTRANCE

NECK EAST (M98)

DEAD NECK

MATCH LINE SHEET NO. 3

Flood

Ebb

N 223 000 | N 222 000 | N 221 000 | N 220 000 | N 219 000 | N 218 000

N 217 000

NOTES

Soundings, probings, and elevations are in feet and tenths and are referred to the plane of Mean Low Water.

Hydrography and probings are from the surveys of March 27 to May 11, 1950 by K. Cole and from May 17 to 31, 1950 by H. A. Fishlock, supplemented with surveys of 1947, 1951, 1953, 1955, 1956 and 1957 by the Department of Public Works of Massachusetts.

Elevations are from the survey of June 2 to 9, 1950 by H. A. Fishlock, supplemented with survey of 1955 by the D.P.W. of Mass..

Topography is from the survey of March 24 to June 28, 1950 by K. Cole, supplemented with surveys of 1951, 1953 and 1955 by the D.P.W. of Mass..

Mean Low Water is shown thus: ·····

6-foot contour is shown thus: – – – – –

12-foot contour is shown thus: –·–·–

Probings are shown thus: 5.4

Recommended Improvement — — —

Considered (not recommended) Improvement — — —

COTUIT HARBOR, MASS.

SURVEY MAP

IN 6 SHEETS — SCALE IN FEET 100 0 100 200 300 400 500 — SHEET 1

NEW ENGLAND DIVISION, BOSTON, MASS. — JUNE 1957

APPROVED: [signature] — CHIEF, ENGINEERING DIVISION

SUBMITTED: [signature] — CHIEF, PLANNING AND REPORTS BRANCH

[signature] — CHIEF, RIVER AND HARBOR SECT.

[signature] — PROJECT ENGINEER

APPROVED: [signature] — BRIG. GEN., U.S. Army, DIVISION ENGINEER

TO ACCOMPANY SURVEY REPORT DATED: JULY 10, 1958

DR. BY F.L. — TR. BY F.L. — CH. BY H.A.F.

FILE NO. Cotuit 4

PLATE 2

CORPS OF ENGINEERS

U. S. ARMY

MATCH LINE

SHEET NO. 6

COTUIT

COTUIT BAY

OSTERVILLE GRAND I.

COTUIT HIGHLANDS

BLUFF POINT

SAMPSONS I.

DEAD NECK

SEAPUIT RIVER

KEG (1950)

TOWN PIER

CHURCH SPIRE (1934)

LEM (1950)

MARSH (1950)

NAM (1950)

NECK WEST (1950)

J.W. Estes

R.M. Robson

Flood

Ebb

N

N 227 000

N 226 000

N 225 000

N 224 000

N 223 000

N 222 000

E 891 000

E 892 000

E 893 000

E 894 000

E 895 000

E 896 000

E 897 000

MATCH LINE SHEET NO. 3

PROBING TABLE

NUMBER OF PROBING	DEPTH IN FEET BELOW M.L.W. WATER	PROBING	INDICATED MATERIAL
1	5.2	8.7	Sand
2	6.0	9.5	Sand & Mud
3	6.1	10.0	" "
4	6.2	9.7	" "
5	6.7	9.7	" "
6	6.7	9.9	" "
7	6.4	10.1	Sand
8	5.0	9.8	"
9	5.9	10.0	"
10	4.1	9.4	"
11	5.3	10.8	Sand & Mud
12	5.3	10.7	" "
13	5.7	10.5	" "
14	6.4	9.1	Sand
15	6.4	8.8	"
16	3.5	8.6	"
17	5.8	9.6	Sand & Mud
18	6.1	9.7	" "
19	6.1	9.5	" "
20	5.7	9.6	" "
21	6.3	12.9	" "
22	5.2	11.8	" "
23	4.5	11.5	" "
24	6.8	11.8	" "

IMPROVEMENTS CONSIDERED

RECOMMENDED:
Channel 8 feet deep, 60 feet wide.

NOT RECOMMENDED:
Desired Channel 12 feet deep, 60 feet wide.
Channel 6 feet deep, 60 feet wide.

For general notes, regional map, and vicinity map, see Sheet No. 1, Plate 2.

LEGEND
FOR
BULKHEADS, RETAINING WALLS
AND GROINS
WOOD
CONCRETE
STONE

COTUIT HARBOR, MASS, SURVEY MAP

IN 6 SHEETS

SCALE IN FEET 100 0 100 200 300 400 500

SHEET 2

NEW ENGLAND DIVISION BOSTON, MASS. JUNE 1957

APPROVED:
CHIEF ENGINEERING DIVISION

SUBMITTED:
CHIEF PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

PROJECT ENGINEER

DR. BY F.L.

TR. BY F.L.

CH. BY [illegible]

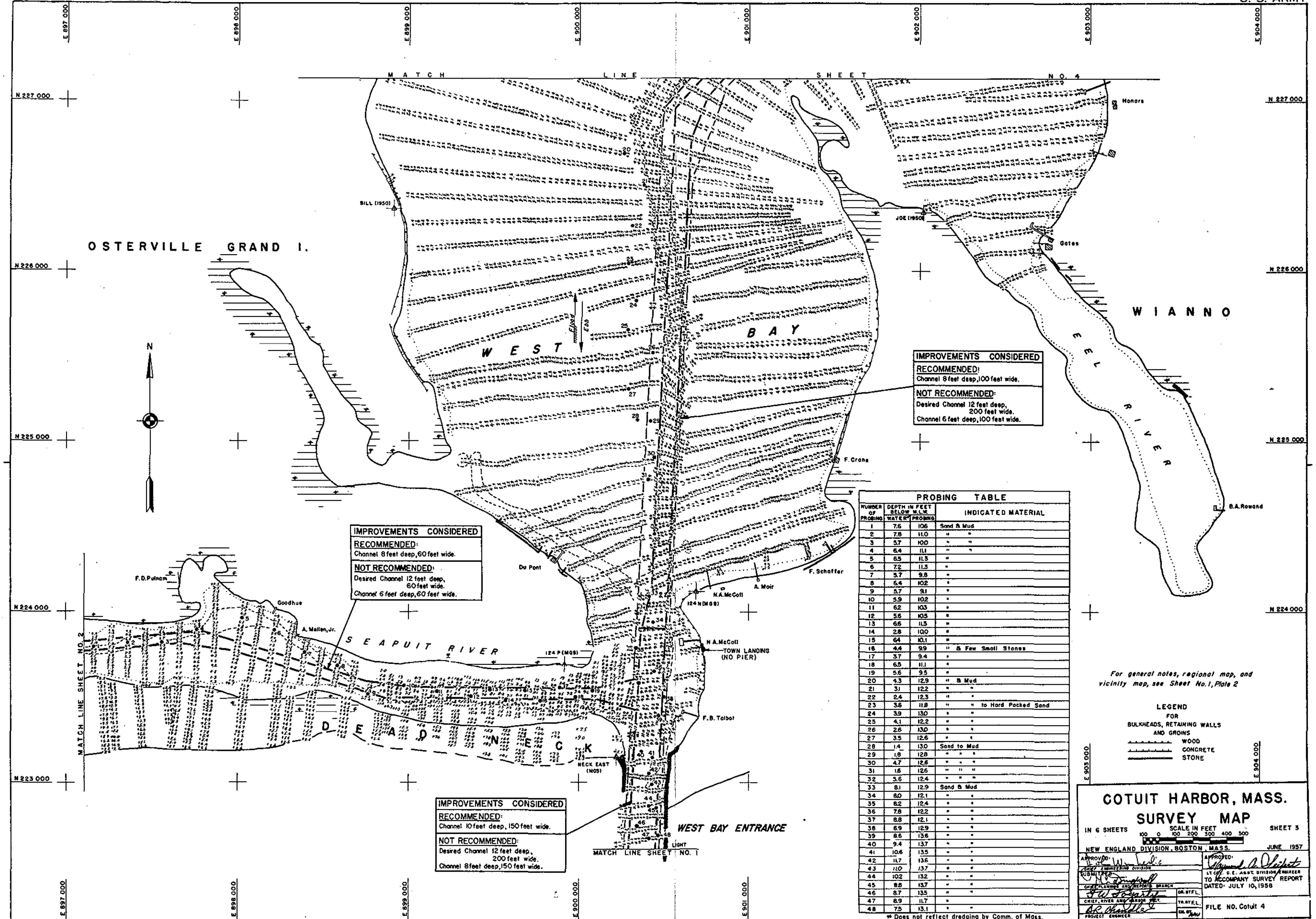
APPROVED:
LT. COL. C.E. ASST. DIVISION ENGINEER

TO ACCOMPANY SURVEY REPORT
DATED: JULY 10, 1958

FILE NO. Cotuit 4

PLATE 3

CORPS OF ENGINEERS U. S. ARMY


MATCH LINE SHEET NO. 4
OSTERVILLE GRAND I.
WEST BAY
WIANNO
EEL RIVER
SEAPUIT RIVER
DEAD NECK
WEST BAY ENTRANCE
MATCH LINE SHEET NO. 1
MATCH LINE SHEET NO. 2
N
BILL (1950)
JOE (1950)
Honors
Gates
F. Crane
F. Schaffer
B.A. Rowand
Du Pont
F.D. Putnam
Goodhue
A. Malten, Jr.
N.A. McColl
A. Moir
124 N (MGS)
124 P (MGS)
TOWN LANDING (NO PIER)
F.B. Talbot
NECK EAST (MGS)
LIGHT
E 897 000
E 898 000
E 899 000
E 900 000
E 901 000
E 902 000
E 903 000
E 904 000
N 227 000
N 226 000
N 225 000
N 224 000
N 223 000
IMPROVEMENTS CONSIDERED
RECOMMENDED:
Channel 8 feet deep, 100 feet wide.
NOT RECOMMENDED:
Desired Channel 12 feet deep, 200 feet wide.
Channel 6 feet deep, 100 feet wide.
IMPROVEMENTS CONSIDERED
RECOMMENDED:
Channel 8 feet deep, 60 feet wide.
NOT RECOMMENDED:
Desired Channel 12 feet deep, 60 feet wide.
Channel 6 feet deep, 60 feet wide.
IMPROVEMENTS CONSIDERED
RECOMMENDED:
Channel 10 feet deep, 150 feet wide.
NOT RECOMMENDED:
Desired Channel 12 feet deep, 200 feet wide.
Channel 8 feet deep, 150 feet wide.
For general notes, regional map, and vicinity map, see Sheet No. 1, Plate 2
LEGEND FOR BULKHEADS, RETAINING WALLS AND GROINS
WOOD
CONCRETE
STONE

PROBING TABLE

NUMBER OF PROBING	DEPTH IN FEET BELOW M.L.W. WATER*	PROBING	INDICATED MATERIAL
1	7.6	10.6	Sand & Mud
2	7.8	11.0	" "
3	5.7	10.0	" "
4	6.4	11.1	" "
5	6.5	11.3	"
6	7.2	11.3	"
7	5.7	9.8	"
8	6.4	10.2	"
9	5.7	9.1	"
10	5.9	10.2	"
11	6.2	10.3	"
12	5.6	10.5	"
13	6.6	11.5	"
14	2.8	10.0	"
15	6.4	10.1	"
16	4.4	9.9	" & Few Small Stones
17	3.7	9.4	"
18	6.5	11.1	"
19	5.6	9.5	"
20	4.3	12.9	" & Mud
21	3.1	12.2	" "
22	2.4	12.3	" "
23	3.6	11.8	" " to Hard Packed Sand
24	3.9	13.0	" "
25	4.1	12.2	" "
26	2.6	13.0	" "
27	3.5	12.6	" "
28	1.4	13.0	Sand to Mud
29	1.8	12.8	" " "
30	4.7	12.6	" " "
31	1.6	12.6	" " "
32	3.6	12.4	" " "
33	8.1	12.9	Sand & Mud
34	8.0	12.1	" "
35	8.2	12.4	" "
36	7.8	12.2	" "
37	8.8	12.1	" "
38	6.9	12.9	" "
39	8.6	13.6	" "
40	9.4	13.7	" "
41	10.6	13.5	" "
42	11.7	13.6	" "
43	11.0	13.7	" "
44	10.2	13.2	" "
45	8.8	13.7	" "
46	8.7	13.5	" "
47	8.9	11.7	"
48	7.5	13.1	" "

* Does not reflect dredging by Comm. of Mass.

COTUIT HARBOR, MASS.
SURVEY MAP

IN 6 SHEETS SCALE IN FEET 100 0 100 200 300 400 500 SHEET 3

NEW ENGLAND DIVISION, BOSTON, MASS. JUNE 1957

APPROVED: CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

PROJECT ENGINEER

DR. BY F.L. TR. BY F.L. CH. BY

APPROVED: LT. COL. C.E. ASST. DIVISION ENGINEER

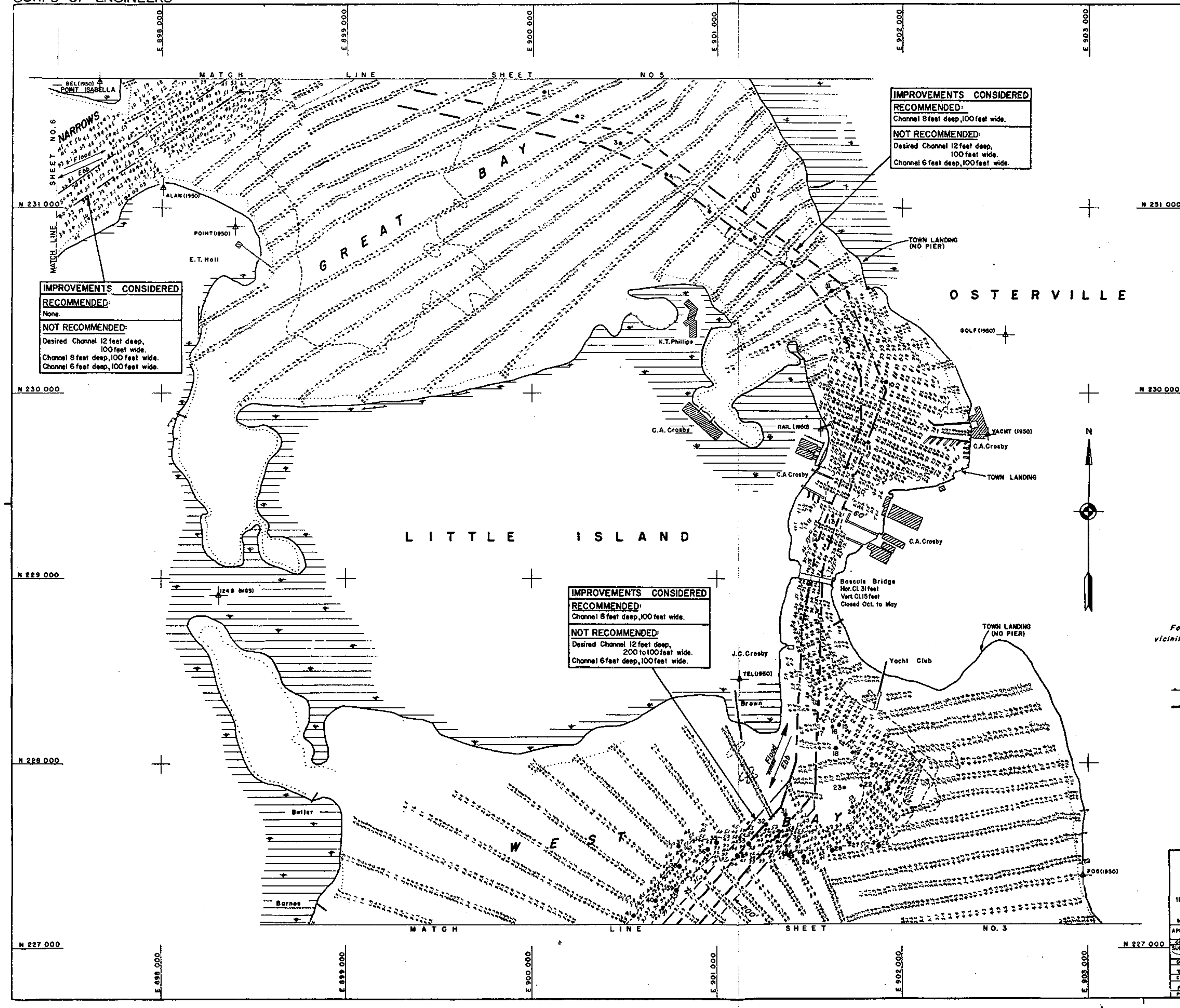
TO ACCOMPANY SURVEY REPORT DATED: JULY 10, 1958

FILE NO. Cotuit 4

PLATE 4

CORPS OF ENGINEERS

U. S. ARMY



IMPROVEMENTS CONSIDERED

RECOMMENDED:

None.

NOT RECOMMENDED:

Desired Channel 12 feet deep, 100 feet wide.
Channel 8 feet deep, 100 feet wide.
Channel 6 feet deep, 100 feet wide.

IMPROVEMENTS CONSIDERED

RECOMMENDED:

Channel 8 feet deep, 100 feet wide.

NOT RECOMMENDED:

Desired Channel 12 feet deep, 100 feet wide.
Channel 6 feet deep, 100 feet wide.

IMPROVEMENTS CONSIDERED

RECOMMENDED:

Channel 8 feet deep, 100 feet wide.

NOT RECOMMENDED:

Desired Channel 12 feet deep, 200 to 100 feet wide.
Channel 6 feet deep, 100 feet wide.

PROBING TABLE

NUMBER OF PROBING	DEPTH IN FEET BELOW* M.L.W. WATER	DEPTH IN FEET BELOW* M.L.W. PROBING	INDICATED MATERIAL
1	5.1	13.0	Mud to Sand
2	5.0	12.9	" " "
3	5.4	12.9	Mud to Sand to Coarse Sand
4	5.5	12.6	Mud to Sand to Clay
5	6.0	12.5	" " " " "
6	6.7	12.5	" " " " "
7	5.6	12.4	" " " " "
8	5.6	12.6	Mud to Sand to Gravel
9	7.5	12.6	" " " " "
10	6.8	12.5	Mud to Sand to Coarse Gravel
11	8.3	12.5	Mud to Sand
12	7.4	12.4	" " "
13	7.3	12.4	" " "
14	6.3	12.4	Sand to Gravel
15	7.0	12.7	Mud
16	5.9	13.2	Sand & Mud
17	1.8	13.1	" "
18	1.9	13.2	" "
19	6.7	13.2	" "
20	6.0	13.3	" "
21	5.9	13.2	" "
22	5.8	13.0	" "
23	2.8	13.7	Sand & Small Stones
24	4.7	13.0	Mud & Sand
25	6.6	13.2	" "
26	4.4	13.3	" "
27	6.6	13.0	Sand & Mud
28	4.1	12.8	Sand
29	5.2	13.4	Sand & Mud
30	7.1	12.9	" "
31	4.7	12.5	" "
32	4.4	12.6	" "
33	6.8	12.9	" "
34	6.4	12.7	" "
35	7.4	12.6	" "
36	6.5	13.6	" "
37	5.6	13.5	" "
38	6.2	13.7	" "
39	4.2	13.9	" "
40	5.7	13.7	" "
41	5.0	13.4	" "

* Does not reflect dredging by Comm. of Mass.

COTUIT HARBOR, MASS.
SURVEY MAP

IN 6 SHEETS — SCALE IN FEET 100 0 100 200 300 400 500 — SHEET 4

NEW ENGLAND DIVISION, BOSTON, MASS. JUNE 1957

APPROVED: [signature] CHIEF, ENGINEERING DIVISION

SUBMITTED: [signature] CHIEF, PLANNING AND REPORTS BRANCH

[signature] CHIEF, RIVER AND HARBOR SECT.

[signature] PROJECT ENGINEER

DR. BY E.L. | TR. BY F.L. | CK. BY A.A.

APPROVED [signature] LT. COL. C.E. ASST. DIVISION ENGINEER

TO ACCOMPANY SURVEY REPORT DATED: JULY 10, 1958

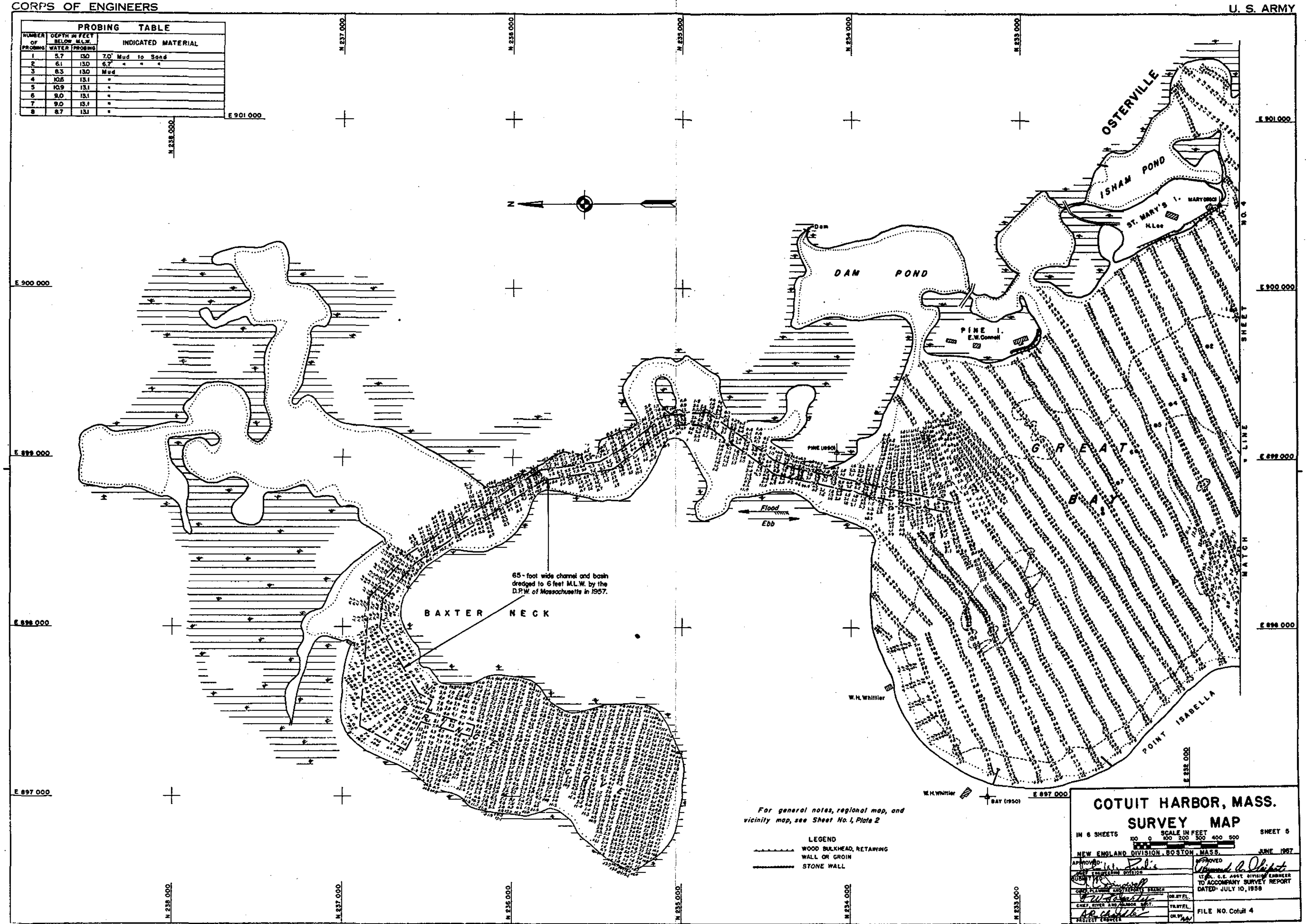
FILE NO. Cotuit 4

CORPS OF ENGINEERS

U. S. ARMY

PROBING TABLE

NUMBER OF PROBING	DEPTH IN FEET BELOW M.L.W. WATER	DEPTH IN FEET BELOW M.L.W. PROBING	INDICATED MATERIAL
1	5.7	13.0	7.0' Mud to Sand
2	6.1	13.0	6.7' " " "
3	8.3	13.0	Mud
4	10.6	13.1	"
5	10.9	13.1	"
6	9.0	13.1	"
7	9.0	13.1	"
8	8.7	13.1	"



OSTERVILLE
ISHAM POND
ST. MARY'S I.
H. Lee
DAM POND
Dam
PINE I.
E.W. Connell
G R E A T
B A Y
BAXTER NECK
Flood
Ebb
POINT ISABELLA
W.H. Whittier
BAY (1950)
MATCH LINE SHEET NO. 4
65-foot wide channel and basin dredged to 6 feet M.L.W. by the D.P.W. of Massachusetts in 1957.
For general notes, regional map, and vicinity map, see Sheet No. 1, Plate 2
LEGEND
WOOD BULKHEAD, RETAINING WALL OR GROIN
STONE WALL
E 901 000
E 900 000
E 899 000
E 898 000
E 897 000
N 238 000
N 237 000
N 236 000
N 235 000
N 234 000
N 233 000
E 232 000

COTUIT HARBOR, MASS.
SURVEY MAP

IN 6 SHEETS — SCALE IN FEET 100 0 100 200 300 400 500 — SHEET 5

NEW ENGLAND DIVISION, BOSTON, MASS. JUNE 1957

APPROVED: CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

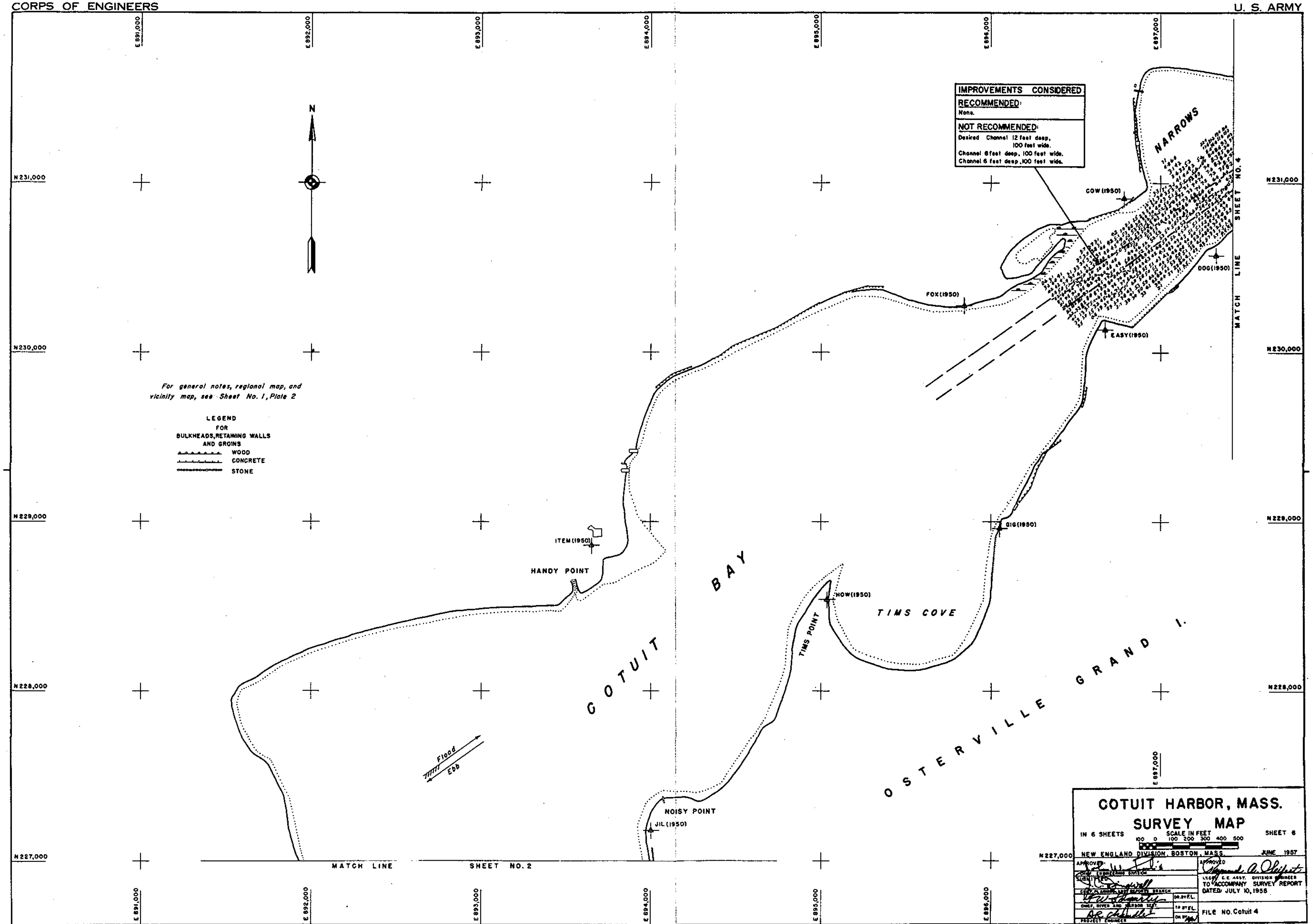
PROJECT ENGINEER

APPROVED: LT. COL., C.E. ASST. DIVISION ENGINEER

TO ACCOMPANY SURVEY REPORT DATED: JULY 10, 1958

FILE NO. Cotuit 4

PLATE 6



IMPROVEMENTS CONSIDERED
RECOMMENDED:
None.
NOT RECOMMENDED:
Desired Channel 12 feet deep, 100 feet wide.
Channel 8 feet deep, 100 feet wide.
Channel 6 feet deep, 100 feet wide.
NARROWS
COW (1950)
DOG (1950)
FOX (1950)
EASY (1950)
GIG (1950)
HOW (1950)
ITEM (1950)
JIL (1950)
HANDY POINT
NOISY POINT
TIMS POINT
TIMS COVE
COTUIT BAY
OSTERVILLE GRAND I.
Flood
Ebb
N
For general notes, regional map, and vicinity map, see Sheet No. 1, Plate 2
LEGEND
FOR
BULKHEADS, RETAINING WALLS AND GROINS
WOOD
CONCRETE
STONE
MATCH LINE SHEET NO. 2
MATCH LINE SHEET NO. 4
E 891,000
E 892,000
E 893,000
E 894,000
E 895,000
E 896,000
E 897,000
N 231,000
N 230,000
N 229,000
N 228,000
N 227,000
COTUIT HARBOR, MASS.
SURVEY MAP
IN 6 SHEETS
SHEET 6
SCALE IN FEET
100 0 100 200 300 400 500
NEW ENGLAND DIVISION, BOSTON, MASS.
JUNE 1957
APPROVED:
CHIEF, ENGINEERING DIVISION
SUBMITTED:
CHIEF, PLANNING AND REPORTS BRANCH
CHIEF, RIVER AND HARBOR SECT.
PROJECT ENGINEER
APPROVED
LT.COL. C.E. ASST. DIVISION ENGINEER
TO ACCOMPANY SURVEY REPORT
DATED: JULY 10, 1958
FILE NO. Cotuit 4

PLATE 7

APPENDIX - COSTS AND BENEFITS

COTUIT HARBOR, MASSACHUSETTS

ESTIMATES OF FIRST COST

1. Estimates of first cost have been prepared for all plans of improvement considered in this report. Probings were made in the hydrographic survey to determine the relative hardness of the material to be dredged and the existence and extent of submerged rock areas. There were no indications of rock in any of the areas considered and all proposed dredging would be of ordinary material consisting of mud and sand. Dredging quantities are in terms of in-place measurement and provide for dredging by hydraulic method to the proposed channel depth plus one foot overdepth. Side slopes of 1 vertical on 3 horizontal were used. The volumes to be dredged in each area of the harbor in accordance with the studied plans are tabulated below:

	Depth of Channel			
	12'	10'	8'	6'
West Bay Entrance	235,000 c.y.	65,000 c.y.	25,000 c.y.	---
West Bay to Great Bay	400,000 c.y.	---	145,000 c.y.	65,000 c.y.
Seapuit River	245,000 c.y.	---	125,000 c.y.	50,000 c.y.
Narrows	135,000 c.y.	---	50,000 c.y.	15,000 c.y.

2. The United States Coast Guard has been consulted and has advised that additional aids to navigation will be required. The estimated additional aids and cost of each for each area of the harbor are tabulated below:

	Additional Aids	Estimated Cost
West Bay Entrance	3 buoys	$1,500
West Bay to Great Bay	7 buoys	$2,500
Seapuit River	5 buoys	$2,000
Narrows	3 buoys	$1,000

3. The costs of construction of the various studied plans of improvement are shown in Table A-1. In addition to the cost of dredging and providing the necessary navigation aids it is estimated that expenditure by local interests for provision of two public landings would be

necessary. One of these landings would be located in West Bay, southeast of the bascule bridge and the other at the head of Great Bay. The cost of these landings (about $14,000) is considered to be self-liquidating and therefore is not included in the project total.

ESTIMATES OF ANNUAL CHARGES

4. The annual shoaling of the channels of the various plans has been estimated upon consideration of the frequency, extent and volume of work performed in the past by local interests and the Commonwealth of Massachusetts, and also in consideration of the areas, dimensions and exposure of the channels. The Seapuit River shoaling rate is based on the use of spoil from project construction and maintenance to strengthen Dead Neck and prevent a breakthrough that would fill the channel. The following is a table of the area of channels of the various plans and the estimated annual deposition over the bottom of the channel.

	Depth of Channel			
	12'	10'	8'	6'
West Bay Entrance				
Area (acres)	25.94	14.69	13.32	
Estimated Annual Deposition (ft.)	0.40	0.30	0.25	
Annual Volume of Shoaling (c.y.)	16,700	7,100	5,400	
West Bay to Great Bay				
Area (acres)	31.68		21.35	20.66
Estimated Annual Deposition (ft.)	0.10		0.08	0.06
Annual Volume of Shoaling (c.y.)	5,100		2,800	2,000
Seapuit River				
Area (acres)	11.48		11.25	11.25
Estimated Annual Deposition (ft.)	0.20		0.17	0.15
Annual Volume of Shoaling (c.y.)	3,700		3,100	2,700
Narrows				
Area (acres)	8.50		8.26	8.04
Estimated Annual Deposition (ft.)	0.08		0.06	0.04
Annual Volume of Shoaling (c.y.)	1,100		800	500

5. The estimated annual carrying charges for the improvements considered in this report have been computed on an assumed life of 50 years and at an interest rate of 2.5 percent. The annual charges and estimated costs of annual maintenance for dredging and navigation aids are shown in Table A-1.

ESTIMATES OF ANNUAL BENEFITS

6. Benefits which would accrue to recreational craft from construction of the improvements have been estimated for all plans under study. In Cotuit Harbor there are essentially two independent fleets; one based in West Bay and Great Bay, the other based in Cotuit Harbor and Seapuit River. These fleets have 366 and 166 craft at present, respectively. The benefits which would accrue to each of these fleets have been estimated separately for each plan studied because the degree of benefits and the effects of the improvements are different for the two fleets. The benefits to recreational craft have been evaluated as the gain in annual return which owners of the craft would enjoy if the improvements were to be constructed.

7. An estimate was made of the ideal annual for-hire return for the various types of boats which can be expected in Cotuit Harbor. This value is expressed as a percentage of the present value of these boats. The extent to which optimum use is possible in the harbor under present conditions and under conditions resulting from the various plans of improvement was also estimated. These values are shown in Table A-2. The factors considered in making these evaluations include concentration of population, access to other small boat harbors, income range of the using public, availability of supplies and services, the draft and length of the particular type of boat, accessibility to the harbor, availability of anchorage, depth, width and alignment of channels, navigational difficulties and safety, scenic and commercial aspects of the harbor, and characteristics of the day sailing area such as weather and exposure. The difference between the percent of optimum use received at present and that expected under a given plan of improvement represents a percentage gain in optimum use. That difference multiplied by the ideal annual return is the gain in annual return for a plan of improvement expressed as a percentage of the present value of a boat.

8. The benefits from the improvements accrue not only to the present two fleets, but also to all craft which would be using the harbor over the life of the project. Such benefits are those which would accrue to the future increase of the fleets from natural growth alone, to new craft purchased solely because of the improvements, to transferred craft because of the improvements, to present transient craft, to the increase of transient craft due to normal growth, and to additional new transient craft which would visit the harbor if it were improved. The expected increases in the number of boats for the various improvements are shown in Table A-3. The estimated benefits from the improvements are discussed below and are tabulated in Tables A-4, A-5, A-6, A-7, A-8, and summarized in Table A-9.

9. The present fleet based at West Bay and Great Bay includes 366 boats of a total depreciated value of $1,367,000 with estimated annual net benefits of about $11,250 for Plans A through F and $4,600 for Plans G through I. The present fleet based at Cotuit Bay and Seapuit River

includes 166 boats of a total depreciated value of $323,000 with estimated net annual benefits of $1,720 for Plan A, $1,640 for Plans B and E, $90 for Plan C, $430 for Plan D, $830 for Plan F, $740 for Plans G and I, and $0 for Plan H. These are computed in Table A-4 of the appendix.

10. The present fleets will undoubtedly grow in number over the life of the project both because of the improvements and also because of the natural growth of the fleets independent of the improvements. The additional craft due solely to the improvement has been separated into new boats purchased and boats transferred to Cotuit Harbor from other harbors. These are discussed in paragraphs 11 and 12. The increase of the present fleets due to normal growth, which is expected to take place regardless of whether the improvements are provided or not, has been estimated to be an average of 50 percent of the present fleets over the life of the project. The benefits thus accruing to the normal growth of the fleets are of the same nature as the benefits to the present fleets. These benefits have been evaluated as 50 percent of the benefits to the present fleet, and amount to $5,630 for Plans A through F and $2,300 for Plans G through I for the West Bay and Great Bay fleet and to $860 for Plan A, $820 for Plans B and E, $40 for Plan C, $210 for Plan D, $420 for Plan F, $370 for Plans G and I, and $0 for Plan H for the Cotuit Bay and Seapuit River fleet.

11. The optimum increase of the fleets, as a result of the improvements and in addition to the normal growth, has been estimated at about 10 percent and 15 percent of the present number of each fleet for the West Bay and Great Bay fleet and the Cotuit Bay and Seapuit River fleet, respectively. It is further estimated that these increases are divided about equally between new and transferred boats as shown in Tables A-5 and A-6. The distribution, as to type and size, of the new and transferred is also shown in these tables. The estimate of the distribution entailed consideration of the probability of the boats locating in the harbor, in the event of improvement, and consideration of the make-up of the existing harbor fleets compared with the normal make-up of fleets in harbors in the general vicinity. It was estimated on this basis that the optimum number of new and transferred boats would be 19 and 17 for the West Bay and Great Bay fleet and 12 and 13 for the Cotuit Bay and Seapuit River fleet, respectively. The number of boats is further dependent on the particular plan, and is estimated to vary as shown in Tables A-5 and A-6.

12. In the estimate of benefits the gain in percent return is computed from the values shown in Table A-2, for each plan studied. The gain to the new boats has been estimated to be the total percent return which may be expected from each plan. The gain to the transferred boats has been estimated at 2/3 of the gain to the present fleet. It is assumed that at present the boats to be transferred are receiving more return at their present harbor than equivalent boats at Cotuit, so that the average gain on transfer would not amount to as much as the gain to the local fleet.

Using the above it was estimated that the net benefits to new boats would be $22,310 for Plan A, $20,050 for Plans B and D through F, $17,300 for Plan C, and $2,750 for Plans G through I for the West Bay and Great Bay fleet and $15,170 for Plans A, B and E, $0 for Plans C and H, $6,480 for Plan D, $2,190 for Plan F and $2,130 for Plans G and I, for the Cotuit Bay and Seapuit River fleet. The net benefits to transferred boats would be $1,950 for Plan A, $1,640 for Plans B and D through F, $1,630 for Plan C and $60 for Plans G through I for the West Bay and Great Bay fleet and $2,840 for Plan A, $2,570 for Plans B and E, $0 for Plans C and H, $700 for Plan D, $130 for Plan F and $60 for Plans G and I for the Cotuit Bay and Seapuit River fleet. Computations of the above benefits are tabulated in Tables A-5 and A-6 for the new and transferred boats, respectively.

13. It has been estimated that an average of about 25 transient boats visit the harbor weekly with an average stay of about 2 to 3 days per boat. These are generally large boats which visit mainly West Bay and Great Bay, where they can be serviced. It is assumed that all benefits to the transient fleet should be credited to improvements in West Bay and Great Bay, and that benefits to transient craft from improvements of Cotuit Bay and Seapuit River are negligible.

14. The number of boat-days of transient craft has been estimated to be 1,500 at present and it is anticipated that the normal future growth will be 50 percent of the present, with additional new transient craft, solely because of the improvements of about 20 percent of the present. It is thus estimated that 750 boat-days due to normal growth, and 280 to 300 boat-days annually, solely because of the improvements may be anticipated. The length of season for Cotuit Harbor has been estimated to be about 165 days and was used in all computations.

15. The gain in percent return to the present and new transient craft has been estimated to be the same as the gain to the present locally based and transferred fleets, respectively. The annual benefits have thus been estimated to be $1,570 for Plan A, $1,400 for Plans B through F, and $360 for Plans G through I for the present transients, $780 for Plan A, $700 for Plans B through F, and $180 for Plans G through I for the transients due to normal growth and $510 for Plan A, $340 for Plans B through F, and $0 for Plans G through I for the new transients. Computations of the benefits to transient craft are tabulated in Table A-7, for the present and Table A-8 for the new transients.

16. Further benefits would accrue from the improvements from elimination of vessel damage. As no information is available concerning present damages it is presumed that benefits from elimination of damages would be small so they have not been evaluated. Additional benefits would also accrue to the small craft which bring seed oysters to Cotuit Harbor. The benefits to these craft have not been evaluated as there are only three or four trips a year involved.

17. Improvement of Cotuit Harbor will make possible its additional use as a harbor of refuge, particularly from hurricanes. It is considered, however, that since adequate facilities are presently available at Hyannis Harbor and Woods Hole, the value of Cotuit as a harbor of refuge would be negligible.

18. It is anticipated that much of the spoil from construction and maintenance of the improvement would be used to strengthen Dead Neck to reduce the shoaling of Seapuit River. Local interests indicated that spoil might also be placed along the shores of West Bay and Great Bay on private beaches. Because the shoreline is now fully developed with expensive residences it is not expected that a material increase in property value would result from spoil disposal. Therefore it is considered that no land enhancement benefit should be credited to the improvement.

19. A further result of the improvement would be an increase in the openings of the bascule bridge. The additional cost for openings for the boats attracted because of an improvement, although a negative benefit, is considered to be negligible.

COMPARISON OF COSTS AND BENEFITS

20. The comparison of costs and benefits on the basis of the evaluations made in the previous sections of this appendix is shown in Table A-10. The plan of improvement which appears to be most favorable from an economic point of view is Plan B, the plan which consists of a 10-foot entrance channel and channels 8 feet deep in West Bay, Great Bay and the Seapuit River. Table A-10 also shows that the desired plan of improvement consisting of 12-foot channels throughout Cotuit Harbor is not economically feasible for the recreational navigation anticipated in the harbor, and that channels of 6 feet in West Bay, Great Bay and the Seapuit River are insufficient for the requirements of the prospective navigation and are not economically feasible.

TABLE A-1 ESTIMATED COSTS OF CONSTRUCTION AND ANNUAL CHARGES

	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTHS									
Entrance	12'	10'	10'	10'	10'	10'	8'	8'	8'
West Bay to Great Bay	12'	8'	8'	8'	8'	8'	6'	6'	6'
Seapuit	12'	8'	-	-	8'	6'	6'	-	6'
Narrows	12'	-	-	8'	8'	-	-	6'	6'
FIRST COST OF CONSTRUCTION									
Project Construction									
Dredging Volume (c.y.)	1,015,000	335,000	210,000	260,000	385,000	260,000	140,000	105,000	155,000
Unit Prices($/c.y.) (April 1958)	1.35	1.55	1.65	1.60	1.50	1.60	1.75	1.85	1.75
Dredging Cost	$1,370,000	$520,000	$345,000	$415,000	$580,000	$415,000	$245,000	$195,000	$270,000
Contingencies	200,000	85,000	50,000	63,000	85,000	62,000	34,000	30,000	42,000
Engineering and Design	10,000	9,000	5,000	6,000	9,000	8,000	7,000	5,000	8,000
Supervision and Administration	90,000	36,000	20,000	26,000	36,000	25,000	14,000	10,000	15,000
Total (April 1958)	$1,670,000	$640,000	$420,000	$510,000	$710,000	$510,000	$300,000	$240,000	$335,000
Pre-Authorization Study Costs	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Other Construction									
Aids to Navigation	7,000	6,000	4,000	5,000	7,000	6,000	6,000	5,000	7,000
TOTAL ESTIMATED PROJECT COST (April 1958)	$1,702,000	$671,000	$449,000	$540,000	$742,000	$541,000	$331,000	$270,000	$367,000
ANNUAL MAINTENANCE									
Volume(c.y.)	26,600	13,000	9,900	10,700	13,800	12,600	10,100	7,900	10,600
Unit Price ($/c.y.) (April 1958)	2.00	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
ANNUAL CHARGES									
Project									
Maintenance Dredging	53,200	29,200	22,300	24,100	31,000	28,400	22,700	17,800	23,800
Interest on Initial Investment	42,400	16,600	11,100	13,400	18,400	13,400	8,100	6,600	9,000
Amortization	17,400	6,800	4,600	5,500	7,500	5,500	3,300	2,700	3,700
Total (April 1958)	$113,000	$52,600	$38,000	$43,000	$56,900	$47,300	$34,100	$27,100	$36,500
NAVIGATION AIDS									
Interest and Amortization	250	200	140	160	250	210	210	160	250
Maintenance	1,050	900	570	710	1,050	890	890	710	1,050
Totals (April 1958)	1,300	1,100	710	870	1,300	1,100	1,100	870	1,300
TOTAL ESTIMATED ANNUAL CHARGES (April 1958)	$114,300	$53,700	$38,710	$43,870	$58,200	$48,400	$35,200	$27,970	$37,800

TABLE A-2 ANNUAL RETURN AND POSSIBLE USE OF RECREATIONAL CRAFT

TYPE OF CRAFT	LENGTH (Feet)	IDEAL ANNUAL RETURN (% of VALUE of CRAFT)	PERCENT OF OPTIMUM USE THAT COULD BE RECEIVED UNDER VARIOUS PLANS								
			PRESENT	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTHS:	ENTRANCE			12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY			12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER			12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS			12'	-	-	8'	8'	-	-	6'	6'
WEST BAY - GREAT BAY FLEET												
Outboards	20 or less	13	100	100	100					100		
Inboards	16 - 25	10	100	100	100					100		
Cruisers	25 - 40	9	100	100	100					100		
	40 - 50	9	90	100	100					95		
	50 - 60	8	85	100	100					90		
	60 - 75	8	80	100	95					85		
	75 - 90	8	70	95	95					80		
Sail	15 or less	12	100	100	100					100		
	15 - 20	12	95	100	100					100		
	20 - 30	11	90	100	100					95		
Auxiliary Sail	30 - 40	9	90	100	100					90		
	40 - 50	8	80	100	95					80		
	50 - 60	8	70	100	90					60		
Charter Boats	30 - 40	8	90	100	100					95		
COTUIT BAY - SEAPUIT RIVER FLEET												
Outboards	20 or less	13	100	100	100	100	100		100	100		
Inboards	16 - 25	10	100	100	100	100	100		100	100		
Cruisers	20 - 30	10	100	100	100	100	100		100	100		
	30 - 45	9	95	100	100	95	95		100	100		
	45 - 60	8	80	100	100	80	90		85	85		
	60 - 75	8	70	95	95	75	85		80	75		
	75 - 90	8	60	90	90	70	80		70	65		
Sail	15 or less	12	100	100	100	100	100		100	100		
	15 - 20	12	90	100	100	90	90		100	100		
	20 - 30	11	80	100	100	80	80		95	95		
Auxiliary Sail	30 - 40	9	70	100	100	70	80		80	75		
	40 - 50	8	60	100	100	65	80		75	70		
	50 - 60	8	50	100	95	55	75		55	50		
Charter Boats	30 - 40	8	90	100	100	90	90		95	95		

Same as Plan B | Same as Plan B | Same as Plan B | Same as Plan B | Same as Present | Same as Plan G | Same as Plan G

TABLE A-3 EXPECTED INCREASES IN NUMBER OF BOATS

NUMBER OF RECREATIONAL CRAFT

(Figures in Parenthesis Represent Number of Transient Boats Equivalent to Local Boats for 165 Day Season)

TYPE OF CRAFT	LENGTH (feet)	PRESENT Local-Trans	EXPECTED FUTURE WITHOUT IMPROVEMENT Local-Trans	ESTIMATED ADDITIONS TO FLEET AFTER IMPROVEMENT FOR VARIOUS PLANS								
				PLAN A Local-Trans	PLAN B Local-Trans	PLAN C Local-Trans	PLAN D Local-Trans	PLAN E Local-Trans	PLAN F Local-Trans	PLAN G Local-Trans	PLAN H Local-Trans	PLAN I Local-Trans
CHANNEL DEPTHS	ENTRANCE			12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY-GREATBAY			12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER			12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS			12'	-	-	8'	8'	-	-	6'	6'
WEST BAY-GREATBAY FLEET												
Outboards	20 or less	100	150	-	-	-				-		
Inboards	16-25	100	150	-	-	-				-		
Cruisers	25-40	40 (1.2)	60 (1.8)	-	-	-				-		
	40-50	15 (1.8)	23 (2.7)	5 (0.1)	5 (0.1)	5 (0.1)				3		
	50-60	6 (1.2)	9 (1.8)	3 (0.2)	3 (0.2)	3 (0.2)				-		
	60-75	- (0.6)	- (0.9)	2 (0.4)	2 (0.3)	2 (0.3)				-		
	75-90	4 -	6 -	-	-	-				-		
Sailboats	15 or less	35 -	52 -	-	-	-	Same as Plan B	Same as Plan B	Same as Plan B	-	Same as Plan G	Same as Plan G
	15-20	30 -	45 -	-	-	-				-		
	20-30	25 (0.6)	38 (0.9)	10 (0.1)	10 (0.1)	9 (0.1)				5		
Auxiliary Sail	30-40	7 (3.1)	10 (4.6)	9 (0.2)	9 (0.2)	8 (0.2)				-		
	40-50	- (0.6)	- (0.9)	3 (0.4)	3 (0.4)	2 (0.4)				-		
	50-60	-	-	2 (0.4)	1 (0.3)	1 (0.3)				-		
Charter Boats	30-40	4	6	2	2	2				1		
TOTALS		366 (9.1)	549 (13.6)	36 (1.8)	35 (1.6)	32 (1.6)	35 (1.6)	35 (1.6)	35 (1.6)	9	9	9
COTUIT BAY - SEAPUIT RIVER FLEET												
Outboards	20 or less	40	60	-	-	-	-		-	-	-	
Inboards	16-25	40	60	-	-	-	-		-	-	-	
Cruisers	20-30	12	18	-	-	-	-		-	-	-	
	30-45	8	12	2	2	-	2		2	2	-	
	45-60	-	-	4	4	-	2		-	-	-	
	60-75	-	-	2	2	-	-		-	-	-	
Sailboats	15 or less	50	75	-	-	-	-		-	-	-	
	20-30	15	22	6	6	-	6		5	5	-	
Auxiliary Sail	30-40	-	1	6	5	-	4		1	-	-	
	40-50	-	-	2	2	-	2		-	-	-	
	50-60	1	1	1	1	-	-		-	-	-	
Charter Boats	30-40	-	-	2	2	-	-		1	1	-	
TOTALS		166	249	25	24	0	16	24	9	8	0	8
TOTALS OF COMBINED FLEETS		532 (9.1)	798 (13.6)	61 (1.8)	59 (1.6)	32 (1.6)	51 (1.6)	59 (1.6)	44 (1.6)	17	9	17

TABLE A-4 BENEFITS FROM IMPROVEMENTS TO PRESENT LOCALLY BASED RECREATIONAL CRAFT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PRESENT NUMBER OF BOATS	TOTAL DEPRECIATED VALUE	VALUE OF GAIN PLAN A %	PLAN A $	PLAN B %	PLAN B $	PLAN C %	PLAN C $	PLAN D %	PLAN D $	PLAN E %	PLAN E $	PLAN F %	PLAN F $	PLAN G %	PLAN G $	PLAN H %	PLAN H $	PLAN I %	PLAN I $
CHANNEL DEPTHS:	ENTRANCE				12		10		10		10		10		10		8		8		8	
	WEST BAY - GREAT BAY				12		8		8		8		8		8		6		6		6	
	SEAPUIT RIVER				12		8		-		-		8		6		6		-		6	
	NARROWS				12		-		-		8		8		-		-		6		6	
WEST BAY - GREAT BAY FLEET																						
Outboards	20 or less	$500	100	$50,000	-	-											-	-				
Inboards	16-25	2,500	100	250,000	-	-											-	-				
Cruisers	25-40	6,000	40	240,000	-	-											-	-				
	40-50	12,500	15	187,500	0.9	1,690											0.5	940				
	50-60	25,000	6	150,000	1.2	1,800											0.4	600				
	75-90	87,500	4	350,000	2.0	7,000											0.8	2,800				
Sailboats	15 or less	400	35	14,000	-	-											-	-				
	15-20	650	30	19,500	0.6	120											0.6	120				
	20-30	1,500	25	37,500	1.1	410											0.6	220				
Auxiliary Sail	30-40	7,500	7	52,500	0.9	470											-	-				
Charter Boats	30-40	4,000	4	16,000	0.8	130											0.4	60				
TOTALS			366	$1,367,000		11,620		11,620		11,620		11,620		11,620		11,620		4,740		4,740		4,740
COTUIT BAY - SEAPUIT RIVER FLEET																						
Outboards	20 or less	$500	40	20,000	-	-	-	-	-	-	-	-	Same as Plan B		-	-	-	-	-	-	Same as Plan G	
Inboards	16-25	2,500	40	100,000	-	-	-	-	-	-	-	-			-	-	-	-	-	-		
Cruisers	20-30	5,500	12	66,000	-	-	-	-	-	-	-	-			-	-	-	-	-	-		
	30-45	9,000	8	72,000	0.5	360	0.5	360	-	-	-	-			0.5	360	0.5	360	-	-		
Sailboats	15 or less	400	50	20,000	-	-	-	-	-	-	-	-			-	-	-	-	-	-		
	20-30	1,500	15	22,500	2.2	500	2.2	500	-	-	-	-			1.7	380	1.7	380	-	-		
Auxiliary Sail	50-60	22,500	1	22,500	4.0	900	3.6	810	0.4	90	2.0	450			0.4	90	-	-	-	-		
TOTALS			166	$323,000		1,760		1,670		90		450		1,670		830		740		0		740
TOTALS OF COMBINED FLEETS			532	$1,690,000		13,380		13,290		11,710		12,070		13,290		12,450		5,480		4,740		5,480

Same as Plan A
Same as Plan A
Same as Plan A
Same as Plan A
Same as Plan A
Same as Plan G
Same as Plan G

TABLE A-4 (Continued) BENEFITS FROM IMPROVEMENTS TO PRESENT LOCALLY BASED RECREATIONAL CRAFT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PRESENT NUMBER OF BOATS	AVERAGE NO. OF DAYS ON CRUISE	VALUE OF ABSENCE ON CRUISE								
					PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTHS:	ENTRANCE				12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY				12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER				12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS				12'	-	-	8'	8'	-	-	6'	6'
WEST BAY - GREAT BAY FLEET													
Outboards	20 or less	$500	100	-	-						-		
Inboards	16-25	2,500	100	-	-						-		
Cruisers	25-40	6,000	40	-	-						-		
	40-50	12,500	15	2	$20						$10		
	50-60	25,000	6	3	30						10		
	75-90	87,500	4	7	300						120		
Sailboats	15 or less	400	35	-	-	Same as Plan A	Same as Plan A	Same as Plan A	Same as Plan A	Same as Plan A	-	Same as Plan G	Same as Plan G
	15-20	650	30	-	-						-		
	20-30	1,500	25	-	-						-		
Auxiliary Sail	30-40	7,500	7	7	20						-		
Charter Boats	30-40	4,000	4	-	-						-		
TOTALS			366		$370	$370	$370	$370	$370	$370	$140	$140	$140
COTUIT BAY - SEAPUIT RIVER FLEET													
Outboards	20 or less	$500	40	-	-	-	-	-					
Inboards	16-25	2,500	40	-	-	-	-	-					
Cruisers	20-30	5,500	12	-	-	-	-	-	Same as Plan B	Same as Plan C	Same as Plan C	Same as Plan C	Same as Plan C
	30-45	9,000	8	1	0	0	-	0					
Sailboats	15 or less	400	50	-	-	-	-	-					
	20-30	1,500	15	-	-	-	-	-					
Aux. Sail	50-60	22,500	1	7	$40	$30	-	$20					
TOTALS			166		$40	$30	$0	$20	$30	$0	$0	$0	$0
TOTALS OF COMBINED FLEETS			532		$410	$400	$370	$390	$400	$370	$140	$140	$140

TABLE A-5 BENEFITS FROM IMPROVEMENTS TO NEW LOCALLY BASED RECREATIONAL CRAFT

NUMBER AND DEPRECIATED VALUE OF BOATS EXPECTED TO BE PURCHASED NEW BECAUSE OF IMPROVEMENT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PLAN A No.	PLAN A Value	PLAN B No.	PLAN B Value	PLAN C No.	PLAN C Value	PLAN D No.	PLAN D Value	PLAN E No.	PLAN E Value	PLAN F No.	PLAN F Value	PLAN G No.	PLAN G Value	PLAN H No.	PLAN H Value	PLAN I No.	PLAN I Value
CHANNEL DEPTH:	ENTRANCE		12'		10'		10'		10'		10'		10'		8'		8'		8'	
	WEST BAY-GREAT BAY		12'		8'		8'		8'		8'		8'		6'		6'		6'	
	SEAPUIT RIVER		12'		8'		-		-		8'		6'		6'		-		6'	
	NARROWS		12'		-		-		8'		8'		-		-		6'		6'	
WEST BAY - GREAT BAY FLEET																				
Cruisers	40-50	$12,500	3	$37,500	3	$37,500	3	$37,500							2	$25,000				
	50-60	25,000	1	25,000	1	25,000	1	25,000							-	-				
	60-75	50,000	1	50,000	1	50,000	1	50,000							-	-				
Sailboats	20-30	2,000	5	10,000	5	10,000	5	10,000	Same as Plan B		Same as Plan B		Same as Plan B		3	6,000	Same as Plan G		Same as Plan G	
Auxiliary Sail	30-40	15,000	5	75,000	5	75,000	4	60,000							-	-				
	40-50	20,000	2	40,000	2	40,000	1	20,000							-	-				
	50-60	25,000	1	25,000	-	-	-	-							-	-				
Charter Boats	30-40	8,000	1	8,000	1	8,000	1	8,000							-	-				
TOTALS			19	$270,500	18	$245,500	16	$210,500	18	$245,500	18	$245,500	18	$245,500	5	$31,000	5	$31,000	5	$31,000
COTUIT BAY - SEAPUIT RIVER FLEET																				
Cruisers	30-45	10,000	1	10,000			-	-	1	10,000			1	10,000						
	45-60	25,000	2	50,000			-	-	1	25,000			-	-						
	60-75	50,000	1	50,000			-	-	-	-			-	-						
Sailboats	20-30	2,000	3	6,000			-	-	3	6,000			3	6,000						
Auxiliary Sail	30-40	15,000	3	45,000			-	-	2	30,000			-	-						
	40-50	20,000	1	20,000			-	-	1	20,000			-	-						
Charter Boats	30-40	8,000	1	8,000			-	-	-	-			1	8,000						
TOTALS			12	$189,000	12	$189,000	0	0	8	91,000	12	$189,000	5	24,000	5	24,000	0	0	5	24,000
TOTALS OF COMBINED FLEETS			31	$459,500	30	$434,500	16	$210,500	26	$336,500	30	$434,500	23	$269,500	10	$ 55,000	5	$31,000	10	$55,000

Same as Plan A

Same as Plan C

Same as Plan F

TABLE A-5 (CONTINUED) - BENEFITS FROM IMPROVEMENTS TO NEW LOCALLY BASED RECREATIONAL CRAFT

VALUE OF GAIN FROM PURCHASE OF NEW BOATS

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PLAN A %	PLAN A $	PLAN B %	PLAN B $	PLAN C %	PLAN C $	PLAN D %	PLAN D $	PLAN E %	PLAN E $	PLAN F %	PLAN F $	PLAN G %	PLAN G $	PLAN H %	PLAN H $	PLAN I %	PLAN I $
CHANNEL DEPTH: ENTRANCE			12'		10'		10'		10'		10'		10'		8'		8'		8'	
WEST BAY - GREAT BAY			12'		8'		8'		8'		8'		8'		6'		6'		6'	
SEAPUIT RIVER			12'		8'		-		-		8'		6'		6'		-		6'	
NARROWS			12'		-		-		8'		8'		-		-		6'		6'	
WEST BAY - GREAT BAY FLEET																				
Cruisers	40-50	$12,500	9.0	3,380	9.0	3,380	9.0	3,380							8.6	2,150				
	50-60	25,000	8.0	2,000	8.0	2,000	8.0	2,000							7.2	-				
	60-75	50,000	8.0	4,000	7.6	3,800	7.6	3,800							6.8	-				
Sailboats	20-30	2,000	11.0	1,100	11.0	1,100	11.0	1,100							10.5	630				
Auxiliary Sail	30-40	15,000	9.0	6,750	9.0	6,750	9.0	5,400							8.1	-				
	40-50	20,000	8.0	3,200	7.6	3,040	7.6	1,520							6.4	-				
	50-60	25,000	8.0	2,000	7.2	-	7.2	-							4.8	-				
Charter Boats	30-40	8,000	8.0	640	8.0	640	8.0	640							7.6	-				
									Same as Plan B		Same as Plan B		Same as Plan B				Same as Plan G		Same as Plan G	
TOTALS				23,070		20,710		17,840		20,710		20,710		20,710		2,780		2,780		2,780
COTUIT BAY - SEAPUIT RIVER FLEET																				
Cruisers	30-45	10,000	9.0	900			8.6	-	9.0	900			9.0	900	9.0	900	8.6	-		
	45-60	25,000	8.0	4,000			6.4	-	7.2	1,800			6.8	-	6.8	-	6.4	-		
	60-75	50,000	7.6	3,800			6.0	-	6.8	-			6.4	-	6.0	-	5.6	-		
Sailboats	20-30	2,000	11.0	660			8.8	-	8.8	530			10.5	660	10.5	630	8.8	-		
Auxiliary Sail	30-40	15,000	9.0	4,050			6.3	-	7.2	2,160			7.2	-	6.8	-	6.3	-		
	40-50	20,000	8.0	1,600			5.2	-	6.4	1,280			6.0	-	5.6	-	4.8	-		
Charter Boats	30-40	8,000	8.0	640			7.2	-	7.2	-			7.6	640	7.6	610	7.2	-		
					Same as Plan A						Same as Plan A								Same as Plan G	
TOTALS				15,650		15,650		0		6,670		15,650		2,200		2,140		0		2,140
TOTALS OF COMBINED FLEETS				38,720		36,360		17,840		27,380		36,360		22,910		4,920		2,780		4,920

TABLE A-5 (CONTINUED) BENEFITS FROM IMPROVEMENTS TO NEW LOCALLY BASED RECREATIONAL CRAFT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	AVERAGE DAYS ON CRUISE	VALUE OF ABSENCE ON CRUISE								
				PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTH:	ENTRANCE			12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY			12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER			12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS			12'	-	-	8'	8'	-	-	6'	6'
WEST BAY - GREAT BAY FLEET												
Cruisers	40-50	$12,500	2	$40	$40	$40				$30		
	50-60	25,000	3	40	40	40	Same as Plan B	Same as Plan B	Same as Plan B	-	Same as Plan G	Same as Plan G
	60-75	50,000	7	170	160	160				-		
Sailboats	20-30	2,000	-	-	-	-				-		
Auxiliary Sail	30-40	15,000	7	290	290	230				-		
	40-50	20,000	7	140	130	70				-		
	50-60	25,000	7	80	-	-				-		
Charter Boats	30-40	8,000	-	-	-	-				-		
TOTALS				$760	$660	$540	$660	$660	$660	$30	$ 30	$30
COTUIT BAY - SEAPUIT RIVER FLEET												
Cruisers	30-45	10,000	1	10		-	10		10			
	45-60	25,000	3	70		-	30		-			
	60-75	50,000	7	160		-	-		-			
Sailboats	20-30	2,000	-	-		-	-		-			
Auxiliary Sail	30-40	15,000	7	170		-	90		-			
	40-50	20,000	7	70		-	60		-			
Charter Boats	30-40	8,000	-	-		-	-		-			
					Same as Plan A			Same as Plan A		Same as Plan F	Same as Plan C	Same as Plan F
TOTALS				$480	$480	$0	$190	$480	$ 10	$10	$ 0	$10
TOTALS OF COMBINED FLEETS				$1,240	$1,140	$540	$850	$1,140	$670	$40	$30	$40

TABLE A-6 BENEFITS FROM IMPROVEMENTS TO TRANSFERRED RECREATIONAL CRAFT

NUMBER AND DEPRECIATED VALUE OF BOATS EXPECTED TO BE TRANSFERRED BECAUSE OF IMPROVEMENT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PLAN A No.	PLAN A Value	PLAN B No.	PLAN B Value	PLAN C No.	PLAN C Value	PLAN D No.	PLAN D Value	PLAN E No.	PLAN E Value	PLAN F No.	PLAN F Value	PLAN G No.	PLAN G Value	PLAN H No.	PLAN H Value	PLAN I No.	PLAN I Value
CHANNEL DEPTH:	ENTRANCE		12'		10'		10'		10'		10'		10'		8'		8'		8'	
	WEST BAY - GREAT BAY		12'		8'		8'		8'		8'		8'		6'		6'		6'	
	SEAPUIT RIVER		12'		8'		-		-		8'		6'		6'		-		6'	
	NARROWS		12'		-		-		8'		8'		-		-		6'		6'	
WEST BAY - GREAT BAY FLEET																				
Cruisers	40-50-	$ 12,500	2	$ 25,000			2	25,000							1	12,500				
	50-60	25,000	2	50,000			2	50,000							-					
	60-75	50,000	1	50,000			1	50,000							-					
Sailboats	20-30	1,500	5	7,500			4	6,000							2	3,000				
Auxiliary Sail	30-40	12,000	4	48,000			4	48,000							-					
	40-50	18,000	1	18,000			1	18,000							-					
	50-60	22,500	1	22,500			1	22,500							-					
Charter Boats	30-40	4,000	1	4,000			1	4,000							1	4,000				
					Same as Plan A				Same as Plan A		Same as Plan A		Same as Plan A				Same as Plan G		Same as Plan G	
TOTALS			17	$ 225,000	17	225,000	16	223,500	17	225,000	17	225,000	17	225,000	4	19,500	4	19,500	4	19,500
COTUIT BAY - SEAPUIT RIVER FLEET																				
Cruisers	30-45	9,000	1	9,000	1	9,000	-		1	9,000			1	9,000	1	9,000				
	45-60	25,000	2	50,000	2	50,000	-		1	25,000			-		-					
	60-75	50,000	1	50,000	1	50,000	-		-				-		-					
Sailboats	20-30	1,500	3	4,500	3	4,500	-		3	4,500			2	3,000	2	3,000				
Auxiliary Sail	30-40	12,000	3	36,000	2	24,000	-		2	24,000			1	12,000	-					
	40-50	18,000	1	18,000	1	18,000	-		1	18,000			-		-					
	50-60	22,500	1	22,500	1	22,500	-		-				-		-					
Charter Boats	30-40	4,000	1	4,000	1	4,000	-		-				-		-					
					Same as Plan B						Same as Plan B						Same as Plan C		Same as Plan G	
TOTALS			13	$ 194,000	12	182,000	0		8	80,500	12	182,000	4	24,000	3	12,000	0		3	12,000
TOTALS OF COMBINED FLEETS			30	$ 419,000	29	407,000	16	223,500	25	305,500	29	407,000	21	249,000	7	31,500	4	19,500	7	31,500

TABLE A-6 (CONTINUED) BENEFITS FROM IMPROVEMENTS TO TRANSFERRED RECREATIONAL CRAFT

TYPE OF CRAFT		LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	VALUE OF GAIN TO TRANSFERRED CRAFT: PLAN A %	PLAN A $	PLAN B %	PLAN B $	PLAN C %	PLAN C $	PLAN D %	PLAN D $	PLAN E %	PLAN E $	PLAN F %	PLAN F $	PLAN G %	PLAN G $	PLAN H %	PLAN H $	PLAN I %	PLAN I $
CHANNEL DEPTH:	ENTRANCE			12'		10'		10'		10'		10'		10'		8'		8'		8'	
	WEST BAY - GREAT BAY			12'		8'		8'		8'		8'		8'		6'		6'		6'	
	SEAPUIT RIVER			12'		8'		-		-		8'		6'		6'		-		6'	
	NARROWS			12'		-		-		8'		8'		-		-		6'		6'	
WEST BAY - GREAT BAY FLEET																					
Cruisers		40-50	12,500	0.6	150	0.6	150	0.6	150							0.3	40				
		50-60	25,000	0.8	400	0.8	400	0.8	400							0.3	-				
		60-75	50,000	1.1	550	0.8	400	0.8	400	Same as Plan B		Same as Plan B		Same as Plan B		0.3	-	Same as Plan G		Same as Plan G	
Sailboats		20-30	1,500	0.7	50	0.7	50	0.7	40							0.4	10				
Auxiliary Sail		30-40	12,000	0.6	290	0.6	290	0.6	290							-	-				
		40-50	18,000	1.1	200	0.8	140	0.8	140							-	-				
		50-60	22,500	1.6	360	1.1	250	1.1	250							0.5	-				
Charter Boats		30-40	4,000	0.5	20	0.5	20	0.5	20							0.3	10				
TOTALS					2,020		1,700		1,690		1,700		1,700		1,700		60		60		60
COTUIT BAY - SEAPUIT RIVER FLEET																					
Cruisers		30-45	9,000	0.3	30	0.3	30		-		-			0.3	30	0.3	30	-	-		
		45-60	25,000	1.1	550	1.1	550		-	0.8	200			0.3	-	0.3	-	-	-		
		60-75	50,000	1.3	650	1.3	650	0.3	-	0.8	-	Same as Plan B		0.5	-	0.3	-	-	-	Same as Plan G	
Sailboats		20-30	1,500	1.5	70	1.5	70	-	-	-	-			1.1	30	1.1	30	-	-		
Auxiliary Sail		30-40	12,000	1.8	650	1.8	430	-	-	0.9	230			0.6	70	0.3	-	-	-		
		40-50	18,000	2.1	380	2.1	380	0.3	-	1.6	290			0.8	-	0.5	-	-	-		
		50-60-	22,500	2.7	610	2.4	540	0.3	-	2.0	-			0.3	-	-	-	-	-		
Charter Boats		30-40	4,000	0.5	20	0.5	20	-	-	-	-			0.3	-	0.3	-	-	-		
TOTALS					2,960		2,670		0		720		2,670		130		60		0		60
TOTALS OF COMBINED FLEETS					4,980		4,370		1,690		2,420		4,370		1,830		120		60		120

TABLE A-6 (Continued) BENEFITS FROM IMPROVEMENTS TO TRANSFERRED RECREATIONAL CRAFT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	AVERAGE DAYS ON CRUISE	VALUE OF ABSENCE ON CRUISE								
				PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTH:	ENTRANCE			12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY			12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER			12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS			12'	-	-	8'	8'	-	-	6'	6'
WEST BAY - GREAT BAY FLEET												
Cruisers	40-50	$12,500	2	-	-					-		
	50-60	25,000	3	$10	$10					-		
	60-75	50,000	7	20	20	Same as Plan B	Same as Plan B	Same as Plan B	Same as Plan B	-	Same as Plan G	Same as Plan G
Sailboats	20-30	1,500	-	-	-					-		
Aux. Sailboats	30-40	12,000	7	10	10					-		
	40-50	18,000	7	10	10					-		
	50-60	22,500	7	20	10					-		
Charter Boats	30-40	4,000	-	-	-					-		
TOTALS				$70	$60	$60	$60	$60	$60	$0	$0	$0
COTUIT BAY-SEAPUIT RIVER FLEET												
Cruisers	30-45	$ 9,000	1	-	-	-	-					
	45-60	$25,000	3	$10	$10	-	-					
	60-75	$50,000	7	30	30	-	-					
Sailboats	20-30	1,500	-	-	-	-	-	Same as Plan B	Same as Plan C	Same as Plan C	Same as Plan C	Same as Plan C
Aux. Sailboats	30-40	12,000	7	30	20	-	$10					
	40-50	18,000	7	20	20	-	10					
	50-60	22,500	7	30	20	-	-					
Charter Boats	30-40	4,000	-	-	-	-	-					
TOTALS				$120	$100	$0	$20	$100	$0	$0	$0	$0
TOTALS OF COMBINED FLEETS				$190	$160	$60	$80	$160	$60	$0	$0	$0

TABLE A-7 BENEFITS FROM IMPROVEMENTS TO PRESENT TRANSIENT RECREATIONAL CRAFT

TYPE OF CRAFT	LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PRESENT NO. OF TRANSIENT BOAT DAYS	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTH:	ENTRANCE			12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY			12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER			12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS			12'	-	-	8'	8'	-	-	6'	6'
				GAIN IN PERCENT RETURN								
Cruisers	25-40	$6,000	200	-	-					-		
	40-50	12,500	300	0.9	0.9					0.5		
	50-60	25,000	200	1.2	1.2					0.4		
	60-75	50,000	100	1.6	1.2					0.4		
Sailboats	20-30	1,500	100	1.1	1.1					0.6		
Auxiliary Sail	30-40	12,000	500	0.9	0.9	Same as Plan B	Same as Plan B	Same as Plan B	Same as Plan B	-	Same as Plan G	Same as Plan G
	40-50	18,000	100	1.6	1.2					-		
				VALE OF GAIN TO PRESENT TRANSIENT CRAFT								
Cruisers	25-40	$6,000	200	-	-					-		
	40-50	12,500	300	210	210					110		
	50-60	25,000	200	360	360					120		
	60-75	50,000	100	480	360					120		
Sailboats	20-30	1,500	100	10	10					10		
Auxiliary Sail	30-40	12,000	500	330	330	Same as Plan B	Same as Plan B	Same as Plan B	Same as Plan B	-	Same as Plan G	Same as Plan G
	40-50	18,000	100	180	130					-		
TOTALS			$1,500	$1,570	$1,400	$1,400	$1,400	$1,400	$1,400	$360	$360	$360

TABLE A-8 BENEFITS FROM IMPROVEMENTS TO NEW TRANSIENT RECREATIONAL CRAFT

TYPE OF CRAFT		LENGTH (Feet)	AVERAGE DEPRECIATED VALUE	PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTHS:	ENTRANCE			12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY			12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER			12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS			12'	-	-	8'	8'	-	-	6'	6'
				NUMBER OF BOAT DAYS OF NEW TRANSIENT CRAFT BECAUSE OF IMPROVEMENT								
Cruisers		40-50	$12,500	20	20					-		
		50-60	25,000	40	40					-		
		60-75	50,000	60	50					-		
Sailboats		20-30	2,000	20	20					-		
Auxiliary Sail		30-40	15,000	40	40	Same as Plan B	Same as Plan B	Same as Plan B	Same as Plan B	-	Same as Plan G	Same as Plan G
		40-50	20,000	60	60					-		
		50-60	25,000	60	50					-		
TOTALS				300	280	280	280	280	280	0	0	0
				VALUE OF GAIN TO NEW TRANSIENT CRAFT								
				% $	% $	% $	% $	% $	% $	% $	% $	% $
Cruisers		40-50	$12,500	0.6 10	0.6 10					0.3 -		
		50-60	25,000	0.8 50	0.8 50					0.3 -		
		60-75	50,000	1.1 200	0.8 120					0.3 -		
Sailboats		20-30	2,000	0.7 -	0.7 -					0.4 -		
Auxiliary Sail		30-40	15,000	0.6 20	0.6 20	Same as Plan B	Same as Plan B	Same as Plan B	Same as Plan B	- -	Same as Plan G	Same as Plan G
		40-50	20,000	1.1 80	0.8 60					- -		
		50-60	25,000	1.6 150	1.1 80					0.5 -		
TOTALS				$ 510	$ 340	$ 340	$ 340	$ 340	$ 340	$ 0	$ 0	$ 0

TABLE A-9 SUMMARY OF ANNUAL BENEFITS FROM IMPROVEMENTS TO RECREATIONAL NAVIGATION

BENEFITS TO RECREATIONAL NAVIGATION

		PLAN A	PLAN B	PLAN C	PLAN D	PLAN E	PLAN F	PLAN G	PLAN H	PLAN I
CHANNEL DEPTH:	ENTRANCE	12'	10'	10'	10'	10'	10'	8'	8'	8'
	WEST BAY - GREAT BAY	12'	8'	8'	8'	8'	8'	6'	6'	6'
	SEAPUIT RIVER	12'	8'	-	-	8'	6'	6'	-	6'
	NARROWS	12'	-	-	8'	8'	-	-	6'	6'
WEST BAY - GREAT BAY FLEET										
Present Locally Based Boats		$11,250	$11,250	$11,250	$11,250	$11,250	$11,250	$4,600	$4,600	$4,600
Natural Growth to Present Locally Based Boats		5,630	5,630	5,630	5,630	5,630	5,630	2,300	2,300	2,300
New Locally Based Boats		22,310	20,050	17,300	20,050	20,050	20,050	2,750	2,750	2,750
Transferred Locally Based Boats		1,950	1,640	1,630	1,640	1,640	1,640	60	60	60
Present Transient Boats		1,570	1,400	1,400	1,400	1,400	1,400	360	360	360
Natural Growth to Present Transient Boats		780	700	700	700	700	700	180	180	180
New Transient Boats		510	340	340	340	340	340	0	0	0
TOTALS		$44,000	$41,010	$38,250	$41,010	$41,010	$41,010	$10,250	$10,250	$10,250
COTUIT BAY - SEAPUIT RIVER FLEET										
Present Locally Based Boats		$1,720	$1,640	$90	$430	$1,640	$830	$740	$ 0	$740
Natural Growth to Present Locally Based Boats		860	820	40	210	820	420	370	0	370
New Locally Based Boats		15,170	15,170	0	6,480	15,170	2,190	2,130	0	2,130
Transferred Locally Based Boats		2,840	2,570		700	2,570	130	60	0	60
TOTALS		$20,590	$20,200	$130	$7,820	$20,200	$3,570	$3,300	$ 0	$3,300
TOTALS OF COMBINED FLEETS		$64,590	$61,210	$38,380	$48,830	$61,210	$44,580	$13,550	$10,250	$13,550

TABLE A-10 Comparison of Benefits and Costs

Plans and Channel Depths - Entrance - West & Great Bay - Seapuit R - Narrows	No. of Locally Based Boats		Transient Boats Equivalent to Locally Based		Total Annual Benefits	Total Annual Charges	Benefit Cost Ratio
	Total	Benefited	Total	Benefited			
Plan A 12-12-12-12	859	234	15.4	13.6	$64,590	$114,300	0.57
Plan B 10- 8- 8- 0	857	232	15.3	13.5	61,210	53,700	1.14
Plan C 10- 8- 0- 0	830	170	15.3	13.5	38,380	38,710	0.99
Plan D 10- 8- 0- 8	849	189	15.3	13.5	48,830	43,870	1.11
Plan E 10- 8- 8- 8	857	232	15.3	13.5	61,210	58,200	1.05
Plan F 10- 8- 6- 0	842	217	15.3	13.5	44,580	48,400	0.92
Plan G 8- 6- 6- 0	815	178	13.6	6.4	13,550	35,200	0.38
Plan H 8- 6- 0- 6	807	135	13.6	6.4	10,250	27,970	0.37
Plan I 8- 6- 6- 6	815	178	13.6	6.4	13,550	37,800	0.36